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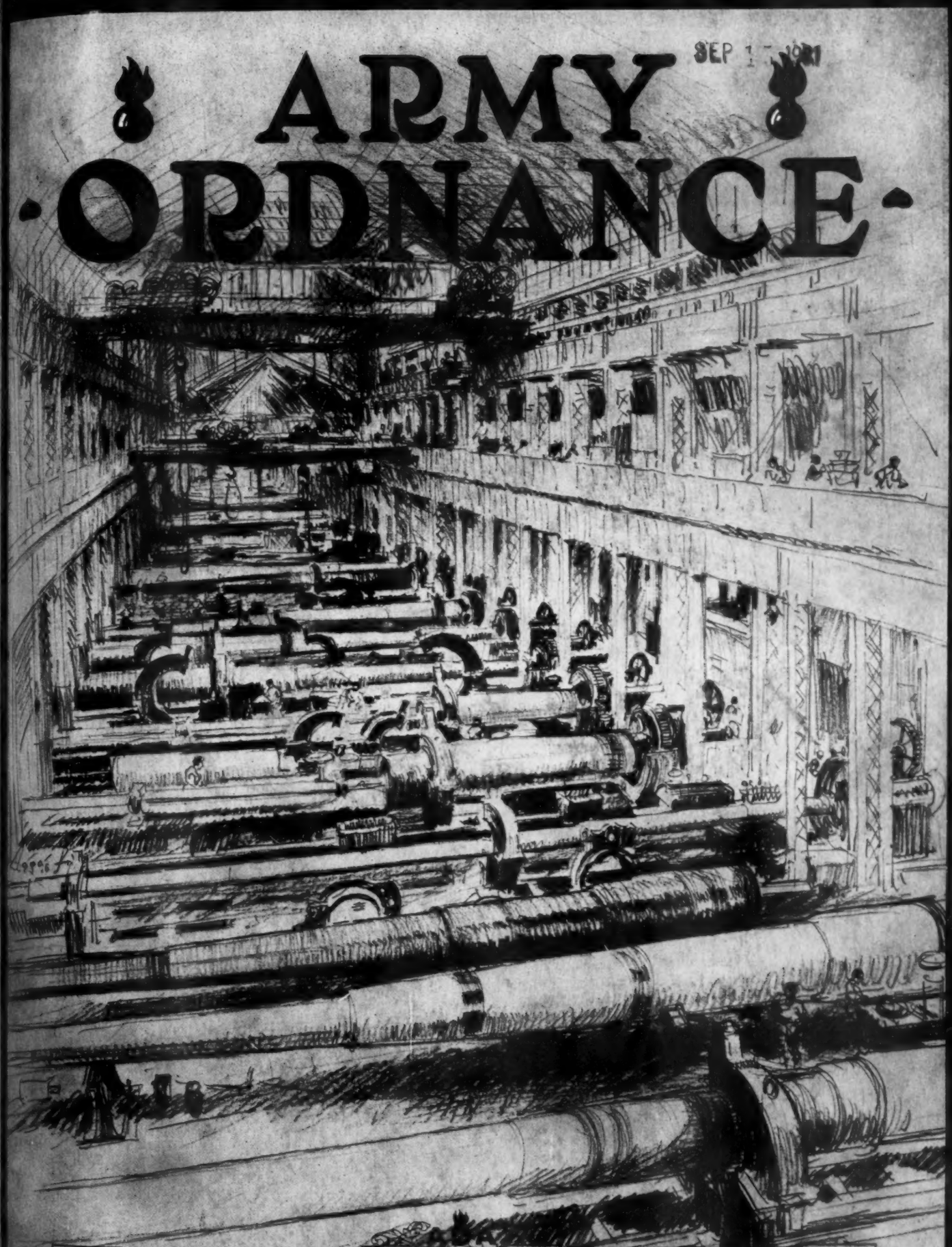
ARMY ORDNANCE



THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

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ARMY ORDNANCE

The Journal of the Army Ordnance Association

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

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"The industrial war plan must conform to the living body of industry—to its customs, practices, organization and character. No human mind can grasp every detail. It can only be developed by years of labor and research. Occupying the space between the continuously changing body of industry and the intermittently changing war plan, it must slowly shape itself to each."

—Patrick J. Hurley, Secretary of War.

The Army Ordnance Association

THE Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness for war as our nation's strongest guarantee of peace.

The Association endeavors to keep alive an interest in and knowledge of the design, production and maintenance of munitions. Other than a few manufacturing arsenals—six in all—there is no peace-time industry for the production of ordnance. Should war unhappily come again, industrial America will be called upon to produce munitions in great quantity and of intricate and unusual design. In an emergency time will not permit careful study or long preparation for the production of munitions. The problem is one of vital concern.

THE Army Ordnance Association believes that the solution of this problem, based on experience, lies in an active organization at all times coöperating with the Government. The principal objective of the Association is an active membership of American citizens, on whom the duty of design and production of munitions will fall in war, who will have an accurate and authentic knowledge of the complex requirements of ordnance. "Peace insurance" in this form is the foremost aim of the Army Ordnance Association.

The Association is purely patriotic; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its officers and directors serve without remuneration.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guarantees of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect cooperation with American scientists, inventors, engineers and manufacturers in civil life and the regular and reserve officers of the Ordnance Department.

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the industry of the nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.

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General Douglas MacArthur

Chief of Staff, United States Army.

ARMY ORDNANCE

VOL. XII SEPTEMBER-OCTOBER, 1931 No. 68

The War Department Mobilization Plan

The Measures Necessary to Insure an Efficient Defense System

By General Douglas MacArthur*

MY STATEMENT will bear upon the requirements of the Joint Resolution under which the Commission is sitting. I shall propose solutions to certain of the problems before you—problems which have long been under study in the War Department.

The first objective given in that resolution is the *promotion of peace*. Under our form of government the War and Navy Departments are not responsible for the formulation of national policies affecting international relationships or internal politics. Consequently, the War Department, as an organization, has no proposals to make to the Commission concerning them. However, it is the duty of the Department to analyze and weigh all factors that have a possible bearing upon the national security. We are required to study continuously the many questions that fall within the scope of our responsibilities, and attempt their answers in the light of prevailing conditions.

As the passage of time thrusts our war experience further and further into the background of the national memory, more and more is forgotten the tragedy of suffering, waste and deprivation that war entails. Succeeding generations tend to visualize peace as a certainty; armed conflict as an impossibility. But through the very nature of their profession, Army and Navy officers are not allowed to forget the true meaning of war, nor to fall into a state of mind that will permit them to contemplate with indifference or complacency the horrors of war, or the possibility of its recurrence.

As a practical step then in the *promotion* of peace, the War Department strives to assist in impressing upon *our own people* the serious and terrible nature of modern war; and the obligation devolving upon every citizen and upon every resource to participate equitably in carrying the burdens it imposes. A widespread knowledge of these fundamental truths, backed by a program to insure a proper distribution of war's burdens, cannot fail to have a sobering influence upon any group tempted from selfish motives to urge the adoption of national policies that might eventually result in international conflict.

However, even a fixed desire of our own people to avoid war does not eliminate the possibility of external aggression. The Department holds to the belief, so often reiterated by our first President, that *a reasonable preparation for defense is one of the best guarantees of peace*, because of its deterring effect upon any government that might contemplate attacking us. The soundness of this belief has been demonstrated more than once in our history, both affirmatively when we were unusually well prepared to exert promptly a strong military pressure, and negatively when we were relatively weak in this respect.

The War Department has the task, under the authority of Congress, of building up a defensive structure that will make hostile attack improbable. It has also the duty of making all preparation, permitted under current Congressional policy, that will, in the event of attack, contribute to the defeat of the enemy and to the elimination of those preventable evils that have made their appearance in all past wars.

While, as I have briefly indicated, War Department activities have some bearing upon efforts to promote peace, yet these activities obviously are more intimately related to the other requirements of the resolution creating this body. In condensed form, I conceive these *other* requirements to comprise definite conclusions and recommendations to the President as to the measures necessary to insure the *efficient and effective* waging of war.

THE history and the phraseology of the resolution are such as to lead us, unless we are watchful, into a serious error. In our attempts to equalize the burdens of, and remove the profits from, war we must guard against a tendency to over-

*Chief of Staff, United States Army.

THIS, the complete War Department Mobilization Plan for both men and munitions in the event of a major war, was presented recently by General MacArthur, Chief of Staff of the Army, before the War Policies Commission. It contains the policies which govern the Department and embodies the thought and study of the years since the World War. Because of the far-reaching importance of the recommendations contained in some of the principal statements before the commission they are being published serially in ARMY ORDNANCE. *The first statement of Mr. Bernard M. Baruch was concluded in the last issue.*

The War Policies Commission, composesd of heads of Executive Departments of the Government and of members of the United States Senate and the House of Representatives, under the Chairmanship of the Secretary of War, in accordance with Public Resolution No. 98 of the 71st Congress, has this and other testimony before it in the formation of recommended policies in the event of a major war. The concluding part of General MacArthur's statement will be published in the next issue of this Journal.—Editor.

emphasize administrative efficiency and under-emphasize national effectiveness. *The objective of any warring nation is victory, immediate and complete.* It is conceivable that a war might be conducted with such great regard for individual justice and administrative efficiency as to make impossible those evils whose existence in past wars inspired the drafting of Public Resolution No. 98—71st Congress. It is also conceivable that the outcome of such a war would be defeat. With defeat would come burdens beside which those we are considering would be relatively insignificant. In all we do and in all we say with reference to preparedness, and to policies to be pursued in event of war, we must never overlook for one moment the fact that while efficiency in war-making is desirable, *effectiveness is mandatory.*

I have assumed in this discussion that the Commission is concerned principally in a possible war of sufficient moment to involve a major military effort by the United States.

An emergency involving no more than the Regular Army, raised to its full strength and perhaps strengthened by some National Guard units, would cause scarcely a ripple in American life and industry. Munitions procurement would closely follow peace-time methods, and there would be no occasion for the application of any governmental control not usually applied in peace. Our plans for such contingencies are exact in detail, and meet every requirement of the situations that might arise.

On the other hand it is conceivable that an emergency may confront us which would require the mobilization of great masses of troops. The War Department classifies any emergency that would require the application of a selective service system as a major one, and it is a possible situation of this nature that is visualized in my discussion.

Our national defense doctrine involves the maintenance in time of peace of the minimum force necessary to hold off any aggressor until the country could prepare itself to wage war. This small standing army would also be called upon to furnish the training cadres for the national army and to supply competent staffs for field armies, corps, and hundreds of lesser units. Today our land forces are reduced to a level that requires the utmost in preparatory measures intended to facilitate the application of our vast resources to war uses, if ever this extreme action should become necessary.

In previous hearings there has been presented to this Commission, by men who occupied key positions in our governmental organization, a comprehensive review of the economic and industrial conditions that characterized our participation in the World War. Assisted by some of these same men, the War Department has studied intensively the history of that conflict in its military, economic, industrial, and social aspects. We attempt to apply the lessons so derived to conditions of the present, which naturally are not, and never can be, the same as those of 1917. As an instance of changed conditions, the present organization of our land forces is totally unlike the one prevailing prior to the World War. Today we have a skeletonized framework of a citizen army capable of absorbing rapidly the military manpower of the nation, whereas in 1917 we had to build up practically a complete organization. Similarly, on the material side we are today in intimate touch with the industrial structure under a plan which will enable American industry promptly to absorb our war requirements. Again, as Mr. Willard and Mr. Aishton pointed out to the Commission, the railways are today far better prepared to meet the requirements of a sudden emergency than they were in 1917.

THE problem is thus much more than one of leisurely historical research—it is an intensely alive and practical process of arranging for the best use of the nation's assets in any emergency of the future—a process in which we are assisted by the experience of the past.

The burdens of war may be roughly classified as human and economic. To a considerable extent these burdens are occasioned by the diversion from normal activities of the manpower, material and money required to organize, equip and maintain essential combatant forces. Time is the vital element in the problem. The necessity for speed permits no gradual absorption of the load. If careful pre-arrangement has not been made, programs involving millions of men and billions of dollars must be hastily extemporized. Consequent confusion, inefficiency, waste and delays, to the point even of jeopardizing national safety, are inescapable. Profiteering and other injustices are attendant evils. *These are the evils the plans and preparations of the War Department are intended to prevent.*

Peace-time training of the armed forces is directed toward the same end. The Regular Army, the National Guard, and the Organized Reserves are developed so as to fit into a great war machine with the least practicable delay, and so as to impose no unnecessary burdens upon industry.

I shall discuss first those phases of our plans that deal with the human burdens of war, pointing out particularly the measures we propose for equalizing these as far as it is practicable to do so.

AS the basis for planning and training, the War Department has adopted General Washington's precept—"If we are wise, let us prepare for the worst." We have a *General Mobilization Plan.* This plan does not envisage any particular enemy. It contemplates the mobilization, by successive periods, of six field armies and supporting troops, or approximately 4,000,000 men. This is a force approximately equal to that we had under arms on November 11, 1918.

From the standpoint of the General Staff, this general plan establishes the basic policies and methods of procedure for a rapid, effective and systematic mobilization of the manpower of the United States. Being arranged by successive periods, the mobilization plan is flexible and can be made to fit the manpower needs of any military situation. It forms the basis of mobilization plans down to and including those of a company or similar unit. It serves to instruct and train military personnel in the problems of mobilization, and in the methods of meeting them. Upon it are built the secret plans to meet specific situations. The plan provides the basis for a continuing study of ways and means for providing the munitions essential to a major war-time effort.

The speed with which effective mobilization can be carried out is dependent upon three factors: *a.* The rapidity with which personnel can be procured; *b.* The length of time required to organize units and train them for combat, and *c.* The rate at which munitions can be manufactured and supplied.

For purposes of planning, the rate at which men can be procured is made the standard, and every effort is bent toward increasing the speed of the other two factors.

A mobilization plan must depend on certain basic assumptions of fact. Upon the correctness of these assumptions depends the successful application of the plan. These assumptions are so important that they deserve the careful attention of the commission. They are:

a. That immediately upon the outbreak of war, the President will be given ample statutory powers to mobilize promptly and to use effectively the manpower and material resources of the nation, and to make such adjustments in governmental agencies so as to mold these resources into efficient organizations.

b. That a selective service act will be passed by the Congress on or before the first day of mobilization.

c. That great cantonments, such as we had in the World War, will not be constructed. Full utilization of federal, state, county, and municipal buildings will be made as troop shelter. Where necessary, arrangements will be made to use privately-owned buildings.

MUCH has been said on the subject of equalizing the burdens of war. All statements on the subject must refer to burdens other than those incident to death and disability, for these can never be equalized. When a nation is called to arms, a partial solution of the problem lies in the adoption of some general system, which recognizes the hazards of war, weighs the rights of individuals against the needs of the state and then fairly determines *who shall fight* and *who shall stay at home*. This question is one that has been much agitated since the World War. I believe that your commission must reach definite conclusions concerning it, and consequently I shall explain in some detail the system that has been developed by the Joint Army-Navy Selective Service Committee, and adopted in the War Department. It is a selective service system based upon the following principles:

a. That provision of the Constitution which sets apart all able-bodied male citizens between the ages of 18 and 45 as the unorganized militia.

b. Group equalization of the burdens of war by selecting, between the ages of 18 and 45, those ages which best fit the needs of the particular war. During the World War this latter range was initially 21 to 30 years, both inclusive.

c. Individual equalization of burdens within the particular ranges of ages selected by means of deferments.

d. Deferments made by a man's neighbors for industrial and humanitarian reasons only.

e. No exemptions.

f. After group selection and individual deferments have been made, calls to service determined by lot.

g. Any disturbance of the economic structure of the nation is to be kept to the practicable minimum.

Briefly, the proposed system operates as follows:

a. The system is administered by a Director of Selective Service, assisted by a national headquarters staff, but is decentralized to each state to be operated within that state under the direction of the governor. The state, in turn, is decentralized into local board areas which include about 30,000 population. In sparsely settled sections the local board areas may include an entire county. If the system were invoked today, there would be roughly 5,000 local boards. Each board will be composed of three members, residents of the local board areas of which they will be representatives.

b. On a day set by proclamation of the President, all male persons within whatever ages he may designate (excepting certain ones of the diplomatic and consular service, and those already in military and naval service) will register at their respective voting precincts.

c. The local board then sends to each registrant a questionnaire. This is designed to give the local board information on the registrant's physical condition, any dependents he may have, his occupation, his religious convictions against war, and his citizenship. In it he may make claims for deferment.

d. From the information thus obtained, the local board will classify each registrant into one of four classes, as follows:

Class I—those immediately available for induction into the public armed forces.

Class II—those whose induction is deferred because of the importance to the nation of the service they are rendering in civilian life.

Class III—those whose induction is deferred because they have dependents, under the meaning of the regulations, mainly dependent upon them for support.

Class IV—those who are deferred from service by law, or whose induction, for obvious reasons, would be undesirable.

e. The registrant may appeal from his classification to a district board of appeals, one of which will have been set up in each federal judicial district.

f. While not a part of either the Army or Navy, close liaison is maintained with them by the Director of Selective Service. With this liaison, the director will know weeks in advance the calls which will be required to fill.

THIS system will provide, say within the ages of 21 and 30, as used in the World War, a reservoir of eleven million registrants. A rough estimate, without taking out the volunteers, indicates that from the registrants will come a Class I of four million men. This number will supply the Army and Navy with sufficient manpower (plus the volunteers in ages 18 to 21) to meet the mobilization plan for the first twelve months. Annually there will be an accretion of approximately 800,000 young men who will have arrived at the age of registration and who will be taken up and added to the rolls. This class will produce a large percentage of fighting men.

From the viewpoint of your commission, the matter of deferments is of paramount importance. It directly concerns the problem of equalizing the burdens of war. As stated before, deferments are contemplated. They cannot be avoided. If the selection of a certain able-bodied man would cause his invalid wife and three small children to become public charges, it is evident that the public interest will not be served. Other similar cases can be imagined, and in the event of war, many thousands will occur. Because of their knowledge of local conditions, the local boards will be able to render acceptable judgments in cases of deferments involving humanitarian considerations, and so tend to equalize the burdens locally.

Deferments involving industry will be more difficult. As in the World War, differences of opinion will arise. They are inevitable. Even with the closest possible liaison between labor, industry and the selective service system, it will be at times impossible for all to agree as to what industries and

factories are essential. After these decisions have been made and disseminated, the questions as to whether a certain man is more essential to industry than to a combat organization will still involve factors about which there can be no unanimity of opinion, especially in the early stages of the war before replacements for men deferred to industry can be trained. For the sake of preserving high national morale, the local boards, supplied with vital information, must be permitted to act in accordance with the particular situation which confronts them.

With 5,000 local boards engaged in selecting fighting men, mistakes are to be expected. But most of these mistakes can be corrected. There are no exemptions, and a deferment once made is not final. In fact, deferments change with conditions, and any man can be reclassified and called when circumstances require. The War Department believes that the system, while not perfect, is sound and will result in a generally satisfactory compromise between the needs of the Army and Navy and those of industry. With the passage of time and longer study of the relation between industry and selective service the proposed system will be improved and refined.

AS previously stated, the basic General Mobilization Plan has set up not only requirements in men, but material requirements as well. Six field armies are composed of corps, divisions, brigades and smaller units, and must be supported by other organizations. Each organization requires its particular unit equipment of rifles, guns, wagons, trucks, and so on almost *ad infinitum*. Each soldier must have shoes, coats, and a multitude of the other accessories of the fighting man. Just as the number of soldiers required during successive periods, beginning with the first day of war, has been estimated for, so has the number of all items of equipment. This information, in the requisite detail, has been furnished to the Assistant Secretary of War. It forms the basis of the industrial researches made by that official, whose aim it is to insure the procurement of all items in the quantities and at the times indicated by those responsible for conducting combat operations.

The matter of procurement is one demanding constant study, revision and compromise. If it can be shown that the demands of the military for certain items cannot be met because of too stringent specifications, then the specifications must be modified. If facilities for the manufacture of certain items are extremely limited, and probably incapable of meeting full war-time needs, then acceptable substitutes must be devised and authorized. The general need for supplying the armed forces within reason with necessaries, and the subsidiary problems growing out of that need, have engrossed the various divisions of the War Department for years. Those of the Assistant Secretary of War are so important, and bear so directly on that of your commission, that they deserve much consideration. I wish to emphasize particularly the importance of the various items of ammunition. Here are commodities produced in small amounts, or not at all, in peace-time, which must be furnished in almost unbelievably large quantities in a major emergency. There is little peace-time requirement for many of them. Furthermore, the production and handling of ammunition and its explosive components by hastily trained personnel involves hazards comparable with those in the zone of combat.

AT this point we bring up that phase of War Department activity which in all its parts, directly or indirectly, affects the distribution of economic burdens in war.

The National Defense Act specifically charges the Assistant Secretary of War with the supervision of the procurement of all military supplies and other business of the War Department pertaining thereto, and the assurance of adequate provision for the mobilization of matériel and industrial organizations essential to war-time needs.

The task imposed by this legislative directive is no simple one. It is easy enough to make the obvious generalization that every material thing and industrial agency shall, in the event of war, serve the state equally with the soldier who bears a rifle in the field. The problem consists in making all pre-arrangements necessary to insure effective use of material resources in war. The system evolved must incorporate the views of the Army, the Navy, and of industry, and must receive the approval of Congress and of the President. The ramifications of the pre-arranging process are almost endless. There are demanded constant study and research. Every progressive idea whose apparent worth stands the test of complete analysis must be given its place in a concrete and living plan that is in consonance with all other preparations.

During the hearings of last March your attention was frequently invited to the lack of industrial preparation prior to our entry into the late conflict. Failure to provide for a coordinated purchasing system in the War Department has been rightly blamed for much of the difficulty that made itself felt in the early months of the war. Moreover, a comprehensive program for effecting the unification of American industrial effort had to be slowly and tediously developed as the war progressed. Experience in modern war has demonstrated that lack of adequate plans for industrial mobilization and for War Department procurement is the source of many evils in war, among which may be listed:

Delay in the procurement of necessary munitions, perhaps even to the point of jeopardizing national safety.

Lack of knowledge concerning the amounts of supplies needed, causing waste of resources in over-production on the one hand, and a shortage of essential items on the other.

Lack of knowledge concerning the most logical places for munitions production, resulting in improper distribution of the load and causing congestion, difficulties in transportation, inefficient use of resources, and local and finally general upsets in the price structure.

Uncoördinated purchasing by many government agencies of tremendous amounts of supplies, encouraging competition among these agencies, and inevitably resulting in further maladjustments in the price structure.

Inequitable distribution of war's economic burdens.

This phase of War Department planning activity deals with two related, yet fairly distinct, problems. The first comprises arrangements for purchasing Army munitions in emergency, *a task that must be carried out in war by the War Department itself*. The second is to develop, in coöperation with the Navy, and other interested agencies, organizational and functional plans to assist the President in controlling America's productive assets in war, a responsibility with which, after any emergency begins, *the combat services will have no direct connection*.

I particularly ask you to observe this line of demarcation

during the remainder of my discussion, since its clear perception is necessary to an understanding of the War Department's preparatory work affecting industrial matters in war.

PLANS for Army procurement are based upon the following general principles:

a. Provisions for procuring equipment must be detailed and exact, and essential production must begin immediately upon the outbreak of war.

b. Army procurement must be coördinated with that of the Navy.

c. The least possible disturbance must be caused in the normal economic life of the country. The production load must be intelligently distributed to all parts of the country.

d. There must be no competitive bidding by governments for the products of industry.

e. Personnel must be secured and trained to build up the highly specialized contracting, inspecting, and fiscal services that will be necessary to the Army in war.

f. To the greatest extent possible industry must receive actual experience in unusual production tasks.

It is obvious that if these things can be accomplished, opportunity for profiteering will be minimized, and the distribution of economic burdens will be facilitated.

In order that the commission may form conclusions as to the influence the procurement methods we are developing will have on the distribution of economic burdens and the elimination of profiteering, I shall sketch briefly the procedure being followed.

From the standpoint of the combat arms, military supplies classify themselves into several rather well defined groups. Each of the Army's supply services is held responsible for the procurement of one of these groups.

The necessity for this specialization and decentralization in Army supply is clearly evident to a student of military matters. A large proportion of the thousands of items needed by troops consists of highly technical, noncommercial articles. A single item may involve the products of many industries, and supplies must be delivered to troops in balanced lots, at exactly the time and place needed. In the aggregate, Army supply involves the whole ramification of industry. These supplies are needed in such volume that the actual work of procuring, transporting and delivering each important class to the combat troops must be performed by a group of specialists. Firm centralized control is exercised—decentralized operation is essential to success in war.

As the initial step in the development of the plan, each procurement service computes the schedule of procurement it must attain in each of the items for which it is held responsible. While statistics have been compiled to show that in the World War our shopping list contained 700,000 different items, this figure included many component parts, and relatively nonessential articles. The vitally essential list now includes about 4,000 articles complete for issue.

A so-called industrial survey is conducted to learn what items each plant is best suited to produce. Capacity of each plant is carefully estimated in order to determine possibilities of procurement. Assistance in this work is obtained from existing governmental agencies, from trade associations, and, in the individual plants, from the actual plant executives. Approximately 15,000 facilities have been surveyed.

To each selected plant there is assigned in our plans a definite task to be undertaken in emergency. The task so assigned does not involve more than 50 per cent of the normal capacity. This provision will effect a wider distribution of the production load; and will permit each plant to maintain on a reduced basis normal commercial contacts, thus minimizing disturbance both at the beginning and at the end of a war. It provides a widely diversified and distributed reserve of production.

Necessary plans with respect to raw materials, labor, power, manufacturing facilities and transportation are developed to insure the delivery of needed finished items. Plans are also made to build up promptly the Army's procurement organization to the required strength.

SOME of the most critical features in the Army procurement plan are those of allocation; preparation of description of manufacture; preparation of plans and studies affecting raw materials; devising of adequate contract forms; and the selection and training of personnel. These subjects I shall discuss briefly to demonstrate their relation to the problems this commission is considering.

Allocations. We plan to base war-time procurement upon allocation rather than upon the competitive bidding standard properly prescribed in peace. By allocation I mean the assignment of a definite list of facilities to each procurement agency to supply its needs. The Navy Department has given its approval to this plan, and, by agreement between both departments, those plants set aside to produce for one are not approached by the other. Under joint agreement certain plants will serve both. The advantages offered by this system are many:

a. It is the only method that permits exact pre-arrangement for production of munitions. The aggregate of the production tasks assigned in peace make up the complete initial requirements of the War Department.

b. Orderly distribution of initial war production can be effected in times of peace. Any other system would throw this load haphazardly upon the country in an intensive purchasing campaign when time is at a premium.

c. Each plant is forewarned of the task it will be expected to perform, and can make some preparation to meet it. Essential production can be initiated with the least practicable delay.

d. Competitive bidding among various agencies for the output of a single plant is prevented.

e. Prices will be determined by negotiation, controlled by the knowledge, obtained in peace-time planning, of the items that make up costs and by all information that can be collected by the Government. A contractor refusing to take a contract at a fair price would be in a most unenviable position in war. The type of contracts designed to assure fair treatment to all will be described later.

I believe the commission should give the weight of its approval to the continuance and further development of this system.

Description of Manufacture. Many articles required by the Army in war are not ordinarily produced in this country, and manufacturers have no prior knowledge of the applicable production methods. Complete drawings and specifications

are necessary to define any given article to a producer. Experimentation and actual production at Government arsenals and laboratories are conducted to develop this information, which, when properly assembled, is called a description of manufacture. The results are preserved in the form of models, drawings, and specifications, lists of operations and factory layouts, summaries of machines and personnel required, and drawings of necessary jigs, dies and fixtures.

The importance of this type of preparation was emphasized by Mr. Coffin as well as by Mr. Ferguson. This work is being done as fast as time and funds will permit. It produces, as a valuable by-product, a force of trained mechanics that may be used as government inspectors or as instructors for others in time of war.

Another method through which these same results could be obtained would be through the placing of educational orders, a subject also discussed at length before the Commission by Mr. Coffin. These have not been authorized by Congress, but are most essential for certain technical items.

An educational order is a contract placed, without advertising, for a limited quantity of a desired technical article, with any selected facility. Their use in peace would be of real advantage in hastening production in an emergency. The selected facility would gain actual experience in producing the article that it would be called upon to produce in war. There would be prepared a complete description of manufacture for the use of the United States, and there would be maintained by the plant a complete set of dies, jigs and fixtures pertaining thereto.

Plans and Studies Affecting Raw Materials. While the United States is economically the most nearly self-contained of any of the great nations, there are certain of the raw materials whose supply, under circumstances interfering materially with our overseas commerce, would cause us great concern.

Commodity committees have been set up to prepare plans concerning such material. These committees make use of all available data collected by other government departments and open up for themselves private sources of information. The research work of the commodity committees in peace covers the following:

a. Study of the supply of the material in the World War and the difficulties encountered.

b. Collection of statistics on the use of the material by industry and the possibility of reducing the industrial requirements in war.

c. Collection of the military, naval and civilian requirements and comparison with the domestic production and sources and amounts of the imports and exports.

There are several constructive steps to be taken to increase the availability of a critical raw material in war. Among the things the Army can do and is doing are:

a. Make the maximum use of acceptable substitutes for the critical material in preparing specifications for essential munitions.

b. Keep in touch with all developments in the United States that promise to make available new sources of supply.

c. Prepare plans for a drastic conservation program to be instituted and executed under the direction of the President in war.

Contract Forms. During the World War the cost-plus and cost-plus-percentage contracts for major construction projects and for the manufacture of large quantities of noncommercial supplies were widely used. The use of such contracts was accompanied by evils which seem difficult, if not impossible, of limitation in war-time activity.

For simple projects and for contracts for commercial articles, the ordinary peace-time fixed-price contracts were used. These were found generally inapplicable to war conditions.

Confusion, opportunity for profiteering by the unscrupulous contractor, and frequent injustice to the patriotic contractor followed.

In 1921 the War Department began the preparation of contract forms which would be adaptable to use in the unsettled economic and industrial conditions of war; which would, so far as possible, relieve the contractors of the perplexing hazards of war-time production; which would facilitate prompt payment and early final settlements; which would avoid the evils accompanying the cost-plus contracts; which would be self-settling in the event that the necessities of the government required termination before completion; and which would protect adequately the government and contractor, and contribute to speedy and early production. In this work advantage has been taken of the experience of contracting officers of the World War. Thousands of business leaders, acquainted with war-time problems, and their present successors have been consulted and have approved the work done. Assistance has been given by officers in other government departments.

The board responsible for this work has recommended:

That for commercial supplies and for relatively simple construction the ordinary peace-time contract forms be used, and that these be modified to meet war conditions. The most important changes relate to clauses providing for settlement in event of termination before completion, and to provisions respecting increased costs of labor and material, when such increases are authorized by federal authority.

That for large construction projects and for the procurement of noncommercial items, the adjusted compensation contract be used. In this form the contracting parties agree in advance upon tentative cost schedules which are revised from time to time as more accurate information becomes available. The government audits all accounts as they arise and pays all approved costs of performance. In the end it also pays the contractor at the rate of 6 per cent per annum on the vlue of his plant involved in the contract. If the contractor has performed the job at a cost less than the *revised estimate* of costs, the government pays him a small added compensation. If actual cost exceeds the estimate, his profit is reduced. Temptation to pad costs is removed.

The profit possible in this contract is *small,* but on the other hand the contractor is not involved in hazards of great loss. The release from these hazards justifies the limitation to a normal peace-time profit.

In the event of war there will be organized in the War Department boards on contracts and boards on claims and adjustments. These will facilitate uniform procedure and prompt settlement. This will be of advantage both to the government and to contractors. After the war there will be little occasion for judicial determination.

(The concluding part of General MacArthur's statement as presented before the War Policies Commission will be published in the November-December issue of this Journal.)

"Mars Peering Into a Sixteen-inch Gun"

Copyright 1931. *Edgar M. Fought, Philadelphia, Pa.*

THIS unusual photograph in which the grim-visaged god of war takes form and feature and peers searchingly into the barrel of a 16-inch gun was taken by Capt. Edgar N. Fought, Med. Res. of Philadelphia, while witnessing the test-firing of seacoast guns at the Aberdeen Proving Ground incident to the Twelfth Annual Meeting of the Army Ordnance Association, October, 1930. It is especially symbolic in this day when questionable theories give rise to the belief that armament is the cause of war. This figure in the cloud, like many of his earthly fellow-citizens, appears to be looking with satisfaction and reliance to his armor as the final gage of peace.

THE THIRTEENTH ANNUAL MEETING

OF THE

ARMY ORDNANCE ASSOCIATION

The National Industrial Conference Board and the United States Naval Institute participating

WILL BE HELD

WEDNESDAY AND THURSDAY, OCTOBER 7th and 8th, 1931

The business and technical session for the discussion of munitions development and the transaction of Association business will be held in the Auditorium of the U. S. Chamber of Commerce Building, Washington, D. C., Wednesday, October 7th, at 8 P. M.

The engineering and scientific session for the observation and study of current tests of ordnance and other Army equipment will be held, with the approval of the Secretary of War, at the Aberdeen Proving Ground, Maryland, Thursday, October 8th, beginning at 10 A. M.

Tentative programs and general information on the following pages.

TENTATIVE PROGRAMS

OF THE SESSIONS OF THE

THIRTEENTH ANNUAL MEETING, ARMY ORDNANCE ASSOCIATION

WEDNESDAY, OCTOBER 7, 1931, 8 P. M.

Auditorium, U. S. Chamber of Commerce Building, Washington, D. C.

BUSINESS AND TECHNICAL SESSION

(*Detailed program will be distributed at the meeting*)

Presiding Officer: Brig. Gen. Benedict Crowell, Ord. Res., President, Army Ordnance Association.

Address: Hon. David A. Reed, United States Senator from Pennsylvania.

Address: Mr. Ernest Lee Jahncke, The Assistant Secretary of the Navy.

Address: Mr. Magnus W. Alexander, President, National Industrial Conference Board.

Foundation and First Awards of the Ordnance Medal of Merit:

Medals will be awarded by direction of the Board of Awards to: Maj. Gen. William Crozier, Col. Robert P. Lamont, and Col. William C. Spruance. Posthumous awards will be made to Brig. Gen. Guy E. Tripp and Maj. Wm. P. Wilson.

Reception Committee, Washington Post, Army Ordnance Association.

Music by the United States Army Band Orchestra.

THURSDAY, OCTOBER 8, 1931, 10 A. M.

Aberdeen Proving Ground, Maryland

ENGINEERING AND SCIENTIFIC SESSION TO WITNESS CURRENT TESTS OF ORDNANCE AND OTHER ARMY EQUIPMENT

(*Detailed program will be distributed at the meeting*)

9:30 A. M.—Arrive Aberdeen Proving Ground.
10:00 A. M.—Main Front. Opening Exercises.
10:10 A. M.—Main Front. Gun Testing Division Firings.
11:00 A. M.—Main Front. Demonstration of Automotive Equipment.
12:00 M. —Lunch.
1:50 P. M.—Main Front. Air Corps Demonstration.
2:45 P. M.—Seacoast Range. Current Tests of Antiaircraft Artillery.
3:45 P. M.—Seacoast Range. Current Tests of Seacoast Artillery.
4:25 P. M.—Aviation Field. Exhibition of Army Aircraft.
5:00 P. M.—Dinner.
6:15 P. M.—Antiaircraft Range. Antiaircraft Artillery Night Firing Tests.

GENERAL ANNOUNCEMENTS

REDUCED RAILROAD FARE

Members of the Army Ordnance Association, the National Industrial Conference Board and the United States Naval Institute can travel to both the Washington and Aberdeen sessions, or to either, at reduced fare by presenting an Identification Certificate to the local railroad ticket agent at practically any point in the United States. Members from northern and eastern points attending the Washington session may purchase a round-trip ticket to Washington with stop-over at Aberdeen, Maryland, on return. Members from western and southern points attending the Washington session may purchase a round-trip ticket to Aberdeen with stop-over at Washington, D. C. Certificates, with invitation and other data, have been sent to members of the Army Ordnance Association and the participating organizations. A round-trip ticket using the Identification Certificate may be purchased at one and one-half times the one-way fare.

SPECIAL TRAINS

A special train of Pullman sleeping cars open for occupancy at 10 P. M., October 7, will leave Pennsylvania Station, New York City, shortly after midnight, October 7-8. Returning, this special train will leave the Proving Ground after the night demonstrations and will arrive in New York in time to make midnight connections for other points. The Secretary, New York Post, Army Ordnance Association, 39 Whitehall Street, New York City, will purchase accommodations for those who desire to travel on this train.

It is contemplated that special cars will be operated from Springfield, Mass. (and intermediate Connecticut cities), Pittsburgh, Pa., and Cleveland, Ohio, for the Aberdeen session and return. Those interested in securing accommodations in these cars should address: from Springfield, the General Passenger Agent, New York, New Haven and Hartford Railroad Company, New Haven, Conn.; from Pittsburgh, the Secretary, Pittsburgh Post, Army Ordnance Association, 1014 Diamond Bank Bldg., Pittsburgh, Pa.; and from Cleveland, Mr. A. C. Sigelen, Pennsylvania Railroad Company, 756 Union Trust Building, Cleveland, Ohio.

ADMISSION

Tickets of admission to the sessions of the meeting will not be required. A special area on the Main Front at the Proving Ground will be reserved for members of the Army Ordnance Association and of the participating organizations and their guests. Admission to this area will be by ticket.

MEALS

For the accommodation of those traveling on special trains, dining cars will be available for the service of breakfast, lunch and dinner at the Proving Ground on October 8th. A limited number of additional meals will also be available in dining cars. No advance reservation for these meals will be necessary. Dinner and supper at the Proving Ground will not be served by caterer as in previous years. Concessionaires will be at the Proving Ground to serve sandwiches and light refreshments throughout the day. Guests may also utilize the limited facilities of the Post Exchange for luncheon and supper.

A New Antiaircraft Weapon

The Recently Developed Truck Mount, T1, For the 3-Inch Gun

By G. M. Barnes*

ARTILLERY officers who have had an opportunity to use the post-war antiaircraft weapons and fire-control apparatus appreciate that a new era in the evolution of artillery is at hand. The airplane is primarily responsible for this development, as it was due to the desire to bring accurate fire upon swiftly moving targets that the principles involved in the new system of artillery were discovered.

Previous to the introduction of the airplane as a military weapon, naval vessels were the only fast-moving targets which land artillerymen had been called upon to combat. The guns and fire-control instruments with which accurate and destructive fire could be brought upon naval vessels had been successfully worked out. The effectiveness of this class of artillery was convincingly demonstrated during the last war when the efforts of the combined French and British fleets, the largest fleet ever assembled in the history of the world, to silence the relatively weak Turkish coast defense guns were not only unsuccessful of fulfillment but resulted in very painful losses of men, matériel and morale to the Allies.

Fig. 1. Three-inch Antiaircraft Trailer Mount M2 in Traveling Position. This is the Standard Carriage for the U. S. Army.

The airplane came quickly into prominence as a military weapon in 1914 and steadily became increasingly effective as the war progressed. At first it passed over enemy lines on its many missions with impunity, as far as the artilleryman was concerned. Strenuous efforts were made to find a system of artillery which could place a destructive fire upon this new elusive enemy.

While these efforts resulted in considerable success and while one-fifth of all enemy aircraft destroyed during the World War were accounted for by gun fire, it was evident to those familiar with this artillery that radical changes and improvements in the system would be necessary before the full effectiveness of the gun could be achieved.

At first, many authorities were of the opinion that the best results could be obtained by putting up a barrage of bursting shells through which the enemy aircraft would be required to fly. The system had many advocates and was put into use in this country and abroad. It has since been shown mathematically and by field firing tests that such a system is entirely impractical.

Opposed to this barrage system is the new antiaircraft system of fire in which each shot is accurately aimed at a

*Chief, Design Section, Watertown Arsenal, Watertown, Mass. Major, Ordnance Department, U. S. Army.

Fig. 2. The New Three-inch Antiaircraft Truck Mount. A Self-contained Unit Capable of Speeds of 50 miles per hour, Possessing Remarkable Cross-country Mobility.

pre-determined position in the heavens and yet the fire is continuous. Every shot is fired with the gun laid in accordance with the most accurate data which can be delivered to it by mathematically correct instruments. As the airplane is moving at a high rate of speed through three-dimensional space, electrical transmission of the calculated data from the fire-control director to the guns is a matter of necessity.

Fig. 3. Three-inch Antiaircraft Truck Mount.
Equipped with tracks ready to negotiate soft mud in which wheels would otherwise be mired.

Aircraft thus brought about the development of a complicated but mathematically correct system of fire control for guns necessitating the building of the most intricate computing means and electrical devices, requiring the use of the latest achievements of the electrical age. At the very outset Coast Artillery officers who were to use the new electrical mechanical system were somewhat loath to accept the new order fearing that it could not be maintained under war conditions. Actual tests over a five-year period simulating war conditions have conclusively demonstrated the practicability of the new system and as far as is known there is nothing but enthusiasm for it throughout the service and no thought of returning to the old order.

After the new mathematically correct system of fire control had been worked out it was first successfully applied to guns mounted on carriages securely bolted to concrete foundations which had been accurately leveled. This made it possible to lay the guns with great precision in accordance with the mathematically computed data, so that the greatest possible accuracy of fire could be obtained. Many observers were skeptical as to whether similar effectiveness of gun fire was possible against airplanes if a mobile gun were employed which could not be anchored to a concrete block and thus held rigid during continuous fire. It is a fact that no such gun carriage existed prior to 1925 and the mobile antiaircraft carriages which were then on hand jumped sufficiently at each shot as to preclude the use of any such system.

IT was therefore necessary to evolve a new type of mobile gun carriage, which when placed in the firing position, although not anchored, would remain stationary in position when the gun was fired rapidly at various angles of elevation and azimuth. The antiaircraft carriage which fulfills these requirements is a 3-inch antiaircraft mobile trailer mount M2 (Fig. 1), now the standard carriage for the United States Army. It has been under almost continuous intensive firing tests since the first carriage was completed in 1926. Readers of ARMY ORDNANCE are familiar with this carriage and the remarkable accuracy of the antiaircraft fire which has been obtained with it. This weapon well illustrates the post-war evolution of artillery.

The unit is so constructed that it can travel at high speeds over roads and across country. This is possible through the use of antifriction bearings at the wheel hubs, balloon tires and spring suspension. The carriage can be emplaced in the firing position on the ground with a minimum of ground preparation and in a remarkably short time. When in the firing position the carriage remains so stable, when the gun is fired, that the orientation of the latter is not disturbed. A leveling device makes it possible to accurately cross-level the carriage. The gun and moving parts of the mount are carried upon antifriction bearings and all gearing is cut by precision methods to insure freedom from lost motion. One should think of this unit as a huge theodolite capable of measuring angles of direction and elevation with great accuracy.

It was only by requiring all instruments in the system from the height finder, the director for computing the firing data, the electrical transmission system to the gun and carriage, to be instruments of precision, as opposed to instruments of approximation, that the present accuracy of fire has been possible.

The 3-inch antiaircraft trailer mount has met all the requirements as to mobility, ease of emplacement, stability and instrument precision, during the five-year intensive firing tests through which it has passed and is now the standard antiaircraft carriage for the United States service. It represents a period of very marked antiaircraft progress.

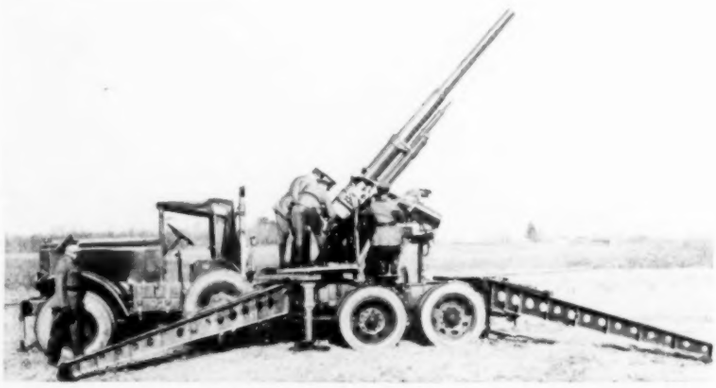


Fig. 4. The Three-inch Antiaircraft Truck Mount during Recent Firing Tests at Sleeve Targets Towed by Airplane.
During the run the target was shot down after 12 shots.

IT may be, therefore, somewhat disturbing to see another antiaircraft unit put forward so soon as a candidate for standardization. This, however, is not as serious as it first seems, since the design is based upon the same gun and many of the same principal parts, such as the recuperator and equilibrators, are used. As the percentage of

commercial parts involved has been increased, peace- or war-time production would be, in fact, simplified by the introduction of the new weapon (Fig. 2).

In designing this new unit the principal thought in mind was to still further increase mobility and to decrease the time required to emplace the mount without decreasing stability or materially interfering with the extremely high rate of fire

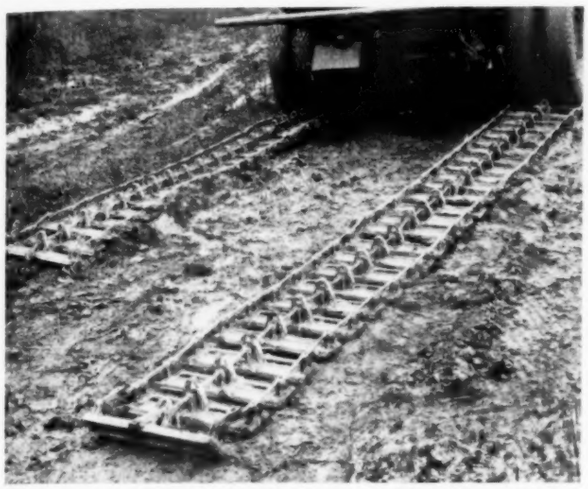


Fig. 5. Removable Light Steel Track for 6-wheeled Truck Mount. Fig. 3 shows track in place.

obtainable with the 3-inch antiaircraft mobile unit. Preliminary trial would indicate that the above advantages have been realized. A brief description of the new weapon follows.

The same high velocity 3-inch antiaircraft gun that is mounted upon the standard 3-inch antiaircraft trailer mount is used in this design. (Figs. 2 and 3.) However, the gun carriage of new construction is mounted directly upon the chassis of a powerful six-wheeled truck. The truck is commercial and could be produced by at least a dozen of the leading truck manufacturers in this country. It is, however, special to the extent that the proper commercial standard units of requisite strength have been combined with a powerful engine having a rating greater than would normally be required for a commercial truck in order to meet the performance specifications required.

This self-contained gun unit is capable of traveling at a speed of 50 miles per hour on level roads. A 500-mile run could readily be made in 24 hours traveling through towns and traffic on improved roads. Some officers have called attention to the fact that such speeds are unnecessary for a mount of this character. However, it may be stated that speed is a corollary of power and that power is essential to give the vehicle the very necessary cross-country mobility and the ability to cross deep sand and mud. Gear ratios which will permit the vehicle to negotiate grades up to 30°, deep mud and loose sand, have been used.

It will be seen from the photograph (Fig. 2) that there are dual balloon tires on all wheels including the front ones. These dual tires present a very large floatation surface to the ground and insure cross-country mobility.

A system of stabilization has been devised for the truck mount in order that it can be quickly emplaced with practically no ground preparation and still furnish a completely stable platform for the gun. Fig. 4 shows the mount in the firing position fully manned. This photograph was taken during recent firings at sleeve targets towed by airplanes. Preliminary tests would indicate that this unit can be placed in the firing position upon arrival at a firing point in about one-half the time now required for emplacing the 3-inch trailer mount. The same saving in time is made when preparing to leave the firing position.

Probably the most important feature of the new design lies in the increased mobility and a few photographs are included to illustrate this. A truck gives the best performance when its load is carried upon its back but is less efficient when the same load is trailed behind it. Computations indicate that a 20-ton prime mover would be required to tow the 3-inch trailer mount (Fig. 8) to give it the same mobility as the truck mount. A prime mover of this size is, of course, not feasible. It has, however, been found by actual test that a prime mover of at least the weight of the complete 3-inch antiaircraft truck mount (including gun and carriage) is required to obtain what might be considered satisfactory mobility for towing the 3-inch antiaircraft trailer mount. There can be no question about the increased mobility of the truck-mounted gun.

Figure 8 illustrates another point clearly brought out during recent tests. The 3-inch truck mount has just successfully passed over this stream but the 3-inch antiaircraft trailer mount, due to the long turning radius of the combined prime mover and mount, has failed to follow directly behind the prime mover pulling it and has become mired so that the truck cannot extricate it. This and similar situations will be met in the field where the short self-contained load of the truck-mounted gun will be found superior to the longer unit formed by the trailer mount and its prime mover.

THERE are periods in the fall and spring every year when the ground is water soaked, soft and mushy. During such times any wheeled truck, two or three axle, can be easily mired off the hard roads. Fig. 7 illustrates what happens under these conditions. Here we see a powerful six-wheeled truck, unloaded, yet unable to move either forward or backward in the mud. For many years the only automotive vehicle which could meet such a situation was the caterpillar tractor. For this reason many still believe that the caterpillar is the only satisfactory type of automotive vehicle for moving artillery in the field. The caterpillar tractor, while meeting all requirements as far as operation in mud are concerned, is very unsatisfactory due to its low speed and short mileage life for operation on ordinary soil or on roads.

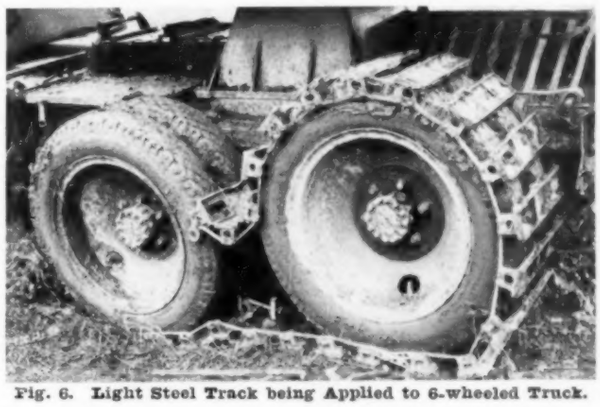


Fig. 6. Light Steel Track being Applied to 6-wheeled Truck.

The writer is of the opinion that the requirements for mobility in mud can be met with a commercial six-wheeled truck provided that this type of vehicle is equipped with a suitable removable track of the type shown in Figs. 3 and 5.

The steel track illustrated is remarkably light, weighing about 200 lbs. per side. It can be applied or removed by trained personnel in about five minutes. When not in use these tracks are carried upon the truck in a space provided therefor. Figs. 5 and 6 show these tracks being applied while Fig. 3 shows the vehicle with the tracks in place. These tracks should be used only when necessary to get the vehicle across soft ground under conditions where it would otherwise become mired. The 3-inch antiaircraft truck mount has readily crossed the marshy ground illustrated in Fig. 8 where no wheeled vehicle without tracks can go. As a matter of fact this truck mount with tracks has crossed swamps where one of the very latest type of high speed tanks became mired. It may be therefore concluded that the six-wheeled truck when equipped with suitable tracks possesses remarkable cross-country mobility.

Fig. 7. A Powerful 6-wheeled Prime Mover without Pay Load Attempting to Cross Swampy Land. It was Promptly Mired, yet the 3-inch Antiaircraft Truck Mount with Tracks (Fig. 3) passed through without Difficulty.

The use of the spare tires located near the cab may be of interest. (Fig. 2.) These spares are mounted on a rigid axle passing in rear of the cab of sufficient strength to support the vehicle at that point. The two spare wheels are located so as to prevent the transmission gears from coming in contact with the ground, when passing over rolling terrain or when leaving or entering a sunken road. Instead of interfering with the ground these wheels come into place raising the front wheels off the ground thus permitting the truck which would otherwise become hung up, to pass over an embankment or other obstruction.

At the present time it is contemplated to use 8 to 10-ton prime movers for the 3-inch antiaircraft trailer mounts M2 carrying about 8 tons of ammunition on each prime mover in addition to its 8-ton trailed load. Under this arrangement each prime mover is required to move across country 24 to 26 tons (8 tons of which is a trailed load), for which 150 h. p. are available, or 6.2 h. p. per ton.

In the case of the 3-inch antiaircraft truck mount, ammunition should be carried on separate trucks of the same total weight, with pay load included, as the truck mount so as to insure equal mobility throughout the battery. In this latter case the maximum load would be 12 tons for which 150 h. p., or 12.5 h. p. per ton, would be available for negotiating cross-country terrain, and there would be no trailed loads.

Only limited firing tests have been conducted to date with this unit, which will be more extensively tested by the Coast Artillery Corps during the coming fall. The writer, however, witnessed the first trials in which the gun was fired at sleeve targets towed by airplanes. With a trained gun crew which had had about an hour's drill on this carriage, the unit was put into action with the towed sleeve target at an altitude of some 13,000 feet. Using only one gun and the newest type of fire control, the target was shot down in about 12 rounds. Another target was put up at about the same altitude and this target was also promptly brought down in some 16 rounds. The officers and men operating the unit agreed that it possessed excellent stability. It is a weapon of high road and cross-country mobility, of accurate and destructive fire against ground and aerial targets.

Fig. 8. Three-inch Antiaircraft Mount and Powerful 6-wheeled Prime Mover. The Mount is Mired. The Truck Mount Successfully Crossed at the Same Point.

The Development of American Industry

The Function of the National Industrial Conference Board

By Magnus W. Alexander

IN periods of prosperity the competitive system, which is the foundation of American industrial activity, functions practically without friction and is generally acclaimed as the basic factor in American social and economic progress. When depression occurs, however, an element of disturbance and disorganization is introduced, which gives rise to complaint that our economic mechanism is unable to adjust itself to the changed business situation. The charge is made that competition is characterized chiefly by planlessness and that, consequently, there is need for the adoption of some new system that will establish a certain degree of direct control over industrial activity. It is assumed that the mistakes of the past would have been avoided and that the evils of business recession might have been averted, if only the course of industry had been guided by some definite plan.

Magnus W. Alexander
President, National Industrial Conference Board.

While it must be admitted that there is too little planning in our economic life, it should be recognized that any policy that would involve the overthrow of the competitive system and the substitution of some form of regimented control over industry would be in conflict with the basic principles of American institutions and the controlling ideals, traditions and habits of the American people. It is possible that, if industry could be organized along military lines, and if the character and the extent of its activities could be directed by a staff of economic experts, a large part of the maladjustment that now manifests itself in periods of depression could be eliminated. But such a disciplined industry could be created only by sacrificing the principle of freedom for private initiative which has been the cornerstone of our economic structure. The spirit of democracy, which permeates American industrial relationships, is incompatible with both bureaucracy and dictatorship. No form of the policy typified in the Five-Year Plan of Soviet Russia could be applied in this country without abandoning forever the ideals of freedom and equality of opportunity.

There is fortunately an alternative method by which social and economic progress can be made more orderly, represented in voluntary coöperation. It is not necessary to discard the competitive system in order to remove the chaos which intensified competition tends to produce. The desired result can be obtained, to a large extent at least, by placing competition on an intelligent plane characterized by a general recognition and understanding of social as well as individual interests. Education is needed for the successful development of a democratic industrial order, as well as a democratic political order. A clear understanding of the general economic situation in all its aspects furnishes a sound basis for wise individual and associative planning in harmony with the activities of others and representative of voluntary coöperation. Coercion in industry interferes with the free operation of the competitive mechanism, but coöperation provides the balance-wheel needed to regulate the movement of that mechanism.

Within the individual branches of industry, the trade association represents the chief agency of cooperation. Through the compilation and dissemination of statistical data relating to production, sales, costs of manufacture and distribution, and other aspects of the competitive situation within a particular industry, the trade association contributes to the development of a solid foundation of factual information on which individual producers and distributors can construct enlightened policies. Furthermore, such associations have tended to remove the suspicion and ill-will formerly created under conditions of cut-throat competition. Although the restrictions imposed by the antitrust laws have limited the scope of coöperation among competitors, the activities of the various trade associations have materially facilitated the development of competition on a sound basis of informed judgment.

In the broader field of industry as a whole, coöperation has been a significant factor in the improvement of economic relationships and in the reconstruction of the competitive system along less individualistic lines. Various agencies have been created for the dissemination of information concerning current business conditions and for the analysis of the perplexing problems of industry, in order that business men might be placed in a position to conduct their operations in accordance with sound economic principles and in harmony with the general social welfare. The development of these agencies may be attributed to the more general recognition of the fact that the planlessness of our competitive system is to a large extent the result of lack of knowledge on the part of industrialists of economic conditions outside of their particular spheres of activity. The World War, by making apparent the need for the integration and correlation of industrial activities, stimulated efforts toward co-

operation and awakened a more general interest in the complexities of the economic system. The result has been a growing realization that the policies of the business man should not be determined solely on the basis of the conditions in his particular field, but should take into account the situation in industry as a whole and the economic problems of the nation.

THIS spirit of coöperation together with the awakened interest in economic problems affecting the national welfare was responsible for the organization in 1916 of the National Industrial Conference Board. Recognizing the fact that the activities of the various trade associations were limited to particular fields and did not extend to the problems of industry as a whole, the founders of the Conference Board conceived the idea of creating a new type of organization, which would not only supplement the work of existing agencies but would also correlate the viewpoints of business men in the separate branches of industry and develop a broad understanding of common interests in the general economic life of the nation. The establishment of the Conference Board, with a membership composed of representatives of affiliated organizations, provided a basis of coöperation among the important trade associations of the country for the comprehensive study and discussion of current economic problems and for the formulation of those sound economic principles which constitute the foundation of industrial prosperity.

In the conduct of its research work and in the presentation of the results of its investigations, the Conference Board has from its inception endeavored to maintain a scientific and impartial attitude toward the problems considered and has always resisted the temptation to engage in propagandist activity. This policy has been instrumental in winning for the Conference Board the support of American industry and the approbation of the general public.

The Conference Board's research activities during the years immediately following its organization were concerned chiefly with the consideration of those questions which directly affected the manufacturer in the operation of his business, including such matters as the purpose and effect of particular industrial relations policies and the earnings of workers in relation to the cost of living. Those early studies have been continued and expanded, thereby providing a basis for the determination of the trend of wages and the changes in the economic status of the workers in manufacturing industry. Gradually, however, the research work of the Conference Board has been extended into other fields. The consideration of wages and the cost of living as social questions led to the discussion of other aspects of the employment relationship, particularly those matters which form the basis of what is called social legislation. The activities of industry are circumscribed by governmental regulations, and it was natural that the Conference Board's investigations should be extended to the analysis of the laws governing business operations. Those investigations dealt with the purpose and effect of the restrictions imposed on industry by the federal antitrust legislation and established a basis of fact for the critical evaluation of that legislation.

The expansion of the Conference Board's research activities during the past fifteen years has been paralleled by an enlargement in the number of organizations and individuals associated with its work. In addition to the designated representatives of affiliated industrial associations, the Board membership now includes representatives of bureaus or departments of the Federal Government that are concerned with industrial activity. A body of councillors, comprising prominent men in various fields of activity, has been created to assist in the direction and development of the work of the Conference Board. Foreign correspondents have also been selected from among the leaders in industry and commerce, finance, statecraft and economics in the principal foreign countries. These correspondents, by their periodical contribution of special articles dealing with conditions in their respective countries and printed in the series of reports entitled, "A Picture of World Economic Conditions," have materially enlarged the viewpoint of American industry and have contributed to a better understanding of world problems.

AN important feature of the Conference Board's work has been the discussion of current problems at the monthly private meetings of the Board members and invited guests. The results of the Conference Board's research work have usually provided a basis for these discussions, although they have not been limited to subjects under investigation by the research staff. It has been the aim of the Conference Board to utilize these monthly conferences for the broad consideration of the outstanding questions of the day and for the exchange of opinion on controversial issues, thereby providing a foundation for coöperation among industrial executives in the solution of the complex problems affecting both the general social welfare and the special interests of industry. The private character of these meetings has facilitated that frank and unrestrained discussion which is necessary to bring to light all aspects of current problems.

In every branch of activity the primary objective of the Conference Board has been the application of sound economic thinking to the problems of our economic life. It has recognized that continued social progress is dependent on the sound development of American industry and on its intelligent participation in the solution of social problems. Industry has need for a larger number of men who know how to coördinate the factors and elements of our complex social structure into an effective organization and who can visualize the broad relations of industry and the economic phases of our national life. The Conference Board does not aim to train executives, but it does endeavor to provide trained executives with the basic knowledge that is essential to the proper adjustment of social and industrial relationships. It seeks to discover and analyze the problems that may handicap the development and progress of industry and to foster that spirit of coöperation which will insure the ultimate solution of those problems and contribute to the further improvement in the economic status of the American people and to the maintenance of American institutions. By scientific investigation and enlightened discussion of the economic factors affecting the national welfare, the Conference Board has been instrumental, without resorting to propaganda methods, in developing a wider public appreciation and understanding of sound economic principles, which constitute an effective defense against false and destructive doctrines of economic relationships and national industrial progress. This is indeed a highly important function.

The New Six-Wheeled Armored Car, T 4

The Four Rear Wheels are Driven and the Hull Itself Forms the Chassis. Here the Windshield is Open.

The Spare Wheels and Tires are Free to Revolve and Assist in Negotiating Rough Terrain. **Other Details on Page 132.**

An Advanced Era of Bullet Velocities

The Attainment of High Speeds and Their Effects on Armor

By H. Gerlich*

AT least a short account will be given in the following pages of certain important results and observations recently obtained in connection with my theoretical and practical pioneer work of increasing decisively the ballistics and effects of our present firearms. In reporting on these results I may be permitted to refer to my previous publications on these subjects and especially to my papers published in No. 9 of the German technical military paper *Heerestechnik* of September 1929 under the heading: "Leistungssteigerung der Infanteriewaffen, Geschossgeschwindigkeit und Taktik" and especially to the concluding passage of this article from my pen. Also I refer to my article published in the May-June, 1930 number of Army Ordnance. Certainly as a practical engineer I should not have concluded my paper published in *Heerestechnik* with the following statement if I had not been perfectly sure of its correctness.

In that statement I said: "It is even possible that—if certain knowledge gained by this time and certain practical experience already available will receive due attention and will be applied—such increases of the ballistics and effects of our firearms may be realized even with our present arms and that the construction and issue of completely new and special arms may be avoided to any great extent. Incidentally, the technical problem would be solved to attain with arms of a smaller caliber and of reduced weight not only the same power, ballistic effects and radius of action as heretofore with arms of greater weight and larger bore, but—in order to meet the highly increased modern requirements, which are not only justified but rather compulsory with regard to ballistic power and effect of our small arms and artillery,—to realize from them even appreciably and decisively better results and efficiency! The successful solving of this technical problem is even now rendered technically possible to a probably quite unforeseen extent." The justification and technical correctness of this statement have since been thoroughly corroborated by further actual results obtained in connection with my pioneer work.

Several military writers have in the meantime referred to the contents of my article in question and I have been approached repeatedly by the editors of the respective technical papers to publish a reply from my own pen. I have however asked that I be permitted to give my reply not by writing and theory, but by *actual* results. I considered such a reply much more worthy of a practical engineer!

This reply I made in the April, 1931, issue of *Heerestechnik*, now published under the title *Wehr und Waffen*, Berlin, under the title: "*Auf dem Wege ballistischen Fortschrittes und der Steigerung der spezifischen Zerstörungswirkung von Geschossen.*"

SINCE my endeavors and practical tests had led in the meantime to certain results, which evidently denoted a fundamental stage of the development and which at the same time supplied the full practical proof of the correctness of my methods, arrangements were recently made to demonstrate and test scientifically my new rifle and cartridge on the grounds of the German Testing Station for Small Arms, Berlin-Wannsee, in the presence of scientific experts. The bullet velocities obtained from my .280 (7-mm.) Halger-Ultra rifle were taken and measured by the officials of the Testing Station with most modern apparatus. I demonstrated on this occasion the penetrating and smashing effects of the cartridge and rifle against modern armor plate. According to the official measurements of the Testing Station and in full accordance with the results of previous tests at the Ammunition Works the average initial velocities of my 7-mm. Ultra bullets weighing 6.5 grams and 9 grams (sectional densities 16.9 g-qcm. and 23.4 g-qcm.) were 4800-4900 ft.-sec. for the 6.5 g. (about 100-grs.) Ultra bullet and 4570-4600 ft.-sec. for the 9 g. (about 139-grs. bullet) in connection with the loading of the Ultra cartridges used in these tests and fired from my first experimental rifle of this type. In previous tests and with different loading of the cartridges still higher bullet-velocities and correspondingly further increased bullet-effects were obtained in the same experimental rifle. Moreover with a new Halger-Ultra bullet of special design and construction having a length of 1 1/16-inch (26½-mm.) and with an improved load an *average* bullet-velocity of 5300 ft.-sec. was attained on June 2, 1931. At the same time there were astonishingly slight differences in the bullet velocities from shot to shot (these velocity variations did not exceed 10 m-sec. or just about 33 ft.-sec. in spite of the very high absolute figure of velocity reached) without any increase of pressure, which was kept within standard limits. With the same new experimental Ultra bullet in connection with another and more powerful load of a special propellant bullet velocities of up to 5800 ft.-sec. have actually been obtained.

It should be noted that these results were obtained with commercial nitrocellulose propellants as readily available, which were not yet specifically tuned-up for this special Halger-Ultra cartridge and its bullets and which therefore were not really suitable for this cartridge and rifle. These propellants could not yet render possible such efficiencies of the loads, which at all events will be realized with specifically tuned-up and more suitable propellants. At present however the objective is only to prove the adaptability and practicability of my methods and to check officially the correctness of the actual results obtained from them so far. This has now been done.

EVEN these *first* increases of velocity thus far realized, which are responsible for the remarkable penetrating and smashing effects of these Halger-Ultra bullets fired and striking with such extraordinarily increased velocities, have created new records. Indeed they are records with an enormous lead over all other heretofore practically realized ballistics of small-arms. At the same time it is beyond any

*Engineer, Kiel, Germany.

doubt whatever, that by constructing the arms especially and by using specifically improved propellants and ammunition, which are now in hand, still very much higher bullet energies will with certainty be realized. Even the doubling of the present ballistics, high though they are, is within the reach of possibility and is attainable according to conscientious technical judgment.

It may be stated, that a specialist in this field, who is known for his calm judgment, and who had witnessed some of my tests, said that my fundamental results constituted in all probability the greatest progress made in one stride in the whole history of the development of practical firearms ballistics! Although we are at present only at the very start of this new development and although it is hardly yet possible to overlook the consequences, there is scarcely any doubt that we have actually entered a new zone and dimension of practical ballistics in obtaining at the same time the respective and specifically new mechanical and dynamic effects of projectiles. Entirely new possibilities should be offered for the coöperation of designers and constructors of arms and projectiles with the powder-specialist and ammunition manufacturer. I purposely avoid passing any definite judgment now and in connection with my present report with regard to the scope and the consequences of such an improved coöperation. Nevertheless the technical conviction is forced upon me, that the rigidity of the heretofore prevailing conditions in this respect may be eliminated to a rather appreciable extent, so that in overcoming the difficulties created by the enforced keeping within certain rigid limits these barriers may be broken down and may be substituted by a rather high relative flexibility and a much larger radius of action in this respect.

My practical experiences and observations accumulated in this respect and the material now available to me admit certain technical conclusions of special importance and constitute in themselves most valuable assets, the practical importance of which is not to be under-rated by anyone.

IF, in connection with the ballistics and power, of our present firearms—small-arms, rifles, larger ordnance—relatively slight improvements have been effected thus far, this period of ballistic development may now be looked upon as being surpassed at least within rather wide limits. It should be remembered that increases of projectile velocities have generally moved only within very modest limits, *i. e.,* by about 50 ft-sec., 100 ft-sec. and perhaps 150 ft-sec. or so. Improvements of projectile velocities are now rendered possible in actual practice to a markedly increased extent and by appreciably and even decisively larger strides in absolute measure. They will be practically attainable with certainty and with the elimination of the usual draw-backs heretofore connected with even minor attempts in this direction. Indeed increases of projectile velocities by straight strides of 600 ft-sec., 1000 ft-sec., 2000 ft-sec. or, according to circumstances, even 3000 ft-sec. are within the reach of practical ballistics and in connection with arms of practical size and weight.

Even my very first experimental Halger-Ultra rifle with its first experimental Ultra cartridge has realized in the same caliber in comparison with the well-known 7-mm. military Mauser cartridge in *one stride* and at the *first attempt* an immediate increase of bullet velocity averaging just about 70 per cent. This tremendous stride could be effected even under the unfavorable and limiting conditions just explained. With regard to the increase of bullet energy a gain of 150 and more per cent, *i. e.,* the practical realization of two and a half times the energy of the former standard 7-mm. military cartridge, has been realized at once and even now. I have in fact obtained with my first experimental Halger Ultra rifle and cartridge of .280-inch or 7-mm. caliber a muzzle-energy of over 900 m-g, *i. e.,* of 6600-7000 ft-lbs. under the conditions stated. There is no question that even in a rifle of so small a bore as 7-mm. or even less bullet-energies of one meter/ton or even appreciably more may be realized in a handy rifle of standard weight and dimensions. Velocities of our present firearms may be developed with relatively heavy bullets of appreciable sectional density with much lower pressures and stresses involved upon the material than have been possible heretofore.

With regard to the arms themselves and indeed with regard to such Ultra rifles from which these highly increased energies may be obtained, it should be pointed out that their overall-length or absolute length of their barrels and their absolute weights will not be increased in comparison with the weight and length of our present arms, in spite of their increased power. I refer to small-arms and rifles exclusively since my means are not sufficient to cover the expenses of building and testing cannons. I refrain purposely from passing judgment with regard to larger guns, although I have been a trained artilleryman and passed my practical apprenticeship in the gun-shops of Messrs. Vickers Sons & Maxim, Ltd., England, more than 30 years ago. The barrel length, and incidentally the whole length of these Halger-Ultra arms, may be reduced in comparison with our present standard arms of various types to a much higher degree without relatively incurring corresponding losses of bullet velocities, thus rendering possible the desired portability of such arms.

IT should also be noted, that my experimental .280 (7-mm.) Halger-Ultra is a magazine rifle with the well-known Mauser bolt-action and that it has functioned in all my tests with the utmost ease and smoothness of the working of the bolt after every shot. The Mauser, after all, is indeed in practice still the best!

Moreover it should be especially noted, that notwithstanding the enormously increased power of this rifle its recoil as felt on the shoulder is not greater than is, for instance, the recoil of the German service Mauser rifle, Model 98, caliber 7.9-mm., when firing from it the former German service cartridge with the 10 gramme (154 grains) Spitzer bullet. This is quite plausible and to a certain extent to be expected. This point may probably be important in connection with the application of Halger-Ultra methods to field and naval guns.

The absolute accuracy of my first experimental rifle or rather the absolute precision of my first cartridges and bullets is such, that they will compete easily with our present accurate standard military or sporting rifles in this respect even at short ranges—not to mention the longer military ranges. Its practical accuracy is of course matchlessly increased and has heretofore never been even approximately approached. Times of flight of Halger-Ultra bullets and vertices of trajectories are of course reduced to a degree, which so far has hardly ever been thought possible—and especially not in connection with a handy rifle. The Halger-

Ultra 9 gramme bullet (139 grs.) or 9.3-gramme bullet (143.5-grains) in its actual design and execution should prove in connection with its high stability, its high C-value and its extraordinary high velocity, ballistically and otherwise, the most efficient military bullet and should in connection with its enormous ranging power and penetrating or bursting effects probably possess a maximum of suitability for military purposes. This bullet is of course shaped as a stream-line (boat-tail) Spitzer bullet of special design. Special notice should be given the high energy of rotation of these Halger-Ultra bullets and their stability in flight when fired and striking with Halger-Ultra velocities. They possess an enormous and astonishing insensibility against all obstructions and will not be diverted by meeting obstacles or severe resistance during their flight or when striking.

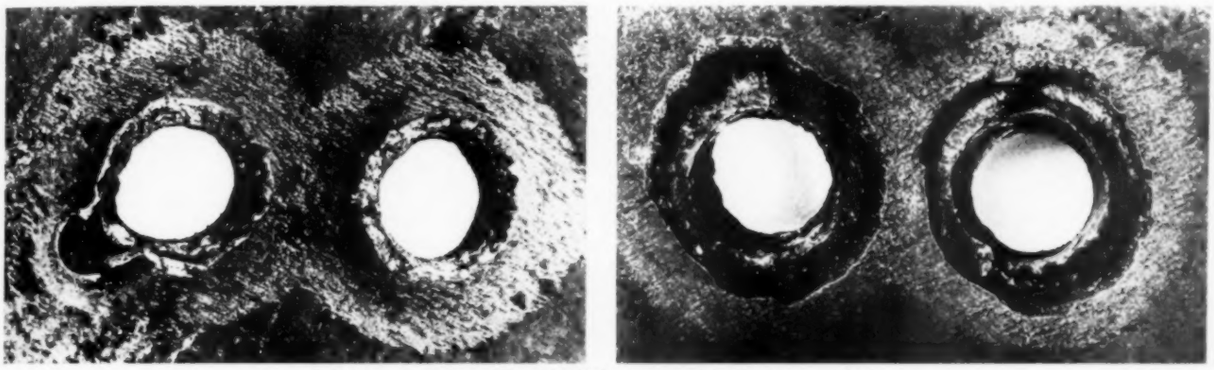
STILL another fact, which is not unimportant in practice, should be pointed out. This is a most interesting observation which proves once more how erroneous and misleading it may be, if the theoretical scientist takes it for granted, that physical laws, which rule and are applicable within the limits of a certain order of magnitude and a certain order of dimension, may be transferred proportionately to limits of other and higher orders of magnitude. Such a transfer is at least partly and within certain limits not at all permissible in many cases and very misleading or sometimes even entirely wrong. As pointed out in my former papers, the absolute increase of gliding friction is not proportionate to the increase of absolute bullet-velocity within the bore. This is quite apart from the fact that losses due to bullet friction are evidently in many cases overrated. The fact is, that providing the diameters of the bearing parts of the bullet, *i. e.*, the forcing of the bullets, are suitably and correctly regulated in proportion to the land and groove diameters and providing correct execution of the bullet jackets and guidings and the bore itself, absolute bullet-friction is not increasing beyond certain limits of velocity with the increase of bullet-velocity, but tends to decrease even absolutely and does actually do so under certain conditions. This is in analogy with a well-known fact. For instance, a juggler may pull his napkin from beneath bottles and glasses by a sufficiently swift motion without upsetting them, which would unavoidably happen if he were doing the trick at a slower rate of speed. I have made the very same observation for the purpose of realizing bullet speeds of higher order. The correctness of these observations is proved by the fact that notwithstanding those bullet velocities, the bores of my Halger-Ultra barrels did not show any metallic fouling whatever. Indeed practically no metallic fouling could be observed even with magnifying optical instruments, with which the bores of my Halger-Ultra barrels were minutely scrutinized. Nor was it traceable by applying an oxidizing ammonia solution, which otherwise and in connection with barrels from which jacketed bullets were fired at the usual standard velocities, showed the well-known blueish coloring of the cleaning patches at once and even after firing but a single shot. It should be noted, that the Halger-Ultra bullet had a soft iron jacket plated with a nickel-copper alloy!

THIS interesting fact, which is certainly important in actual practice, should not be overlooked, although in designing and constructing my Halger-Ultra bullets I have admittedly endeavored to meet as efficiently as possible the specific requirements of actual practice. I hold the opinion that in the majority of bullet designs the guiding and bearing parts of our present projectiles are not yet designed and executed in a really scientific and minutely mechanical sense and do not yet receive the attention and care which is really due to them. I make this statement although I am well aware of the fact that the correct principles of guiding projectiles are not yet, either in theory or practice, explained to such an extent as would be desirable. Designers are evidently sticking too conservatively and empyrically to certain standards and are following the so-called rule of the thumb to a degree hardly any longer permissible. I could not help watching and considering these points in my own way and for some time. It fell to my personal luck to be enabled to make certain not unimportant observations in the course of my special work and tests, which seem to corroborate the correctness of certain theories of mine. I am confidently anticipating that I shall be enabled to make further and still more conclusive observations with regard to these interesting points as soon as the new tuned-up and more suitable propellants for my Halger-Ultra cartridges and arms, which are now in hand, will be available for further tests. These tests will surely lead to an improved efficiency of method in actual practice and to further increases of bullet velocities even in my present experimental Halger-Ultra barrels.

It should prove, by the way, to be of special interest to investigate the slope of the curve of air resistance offered to projectiles within such higher velocity zones by means of the stable Halger-Ultra bullets moving with so highly increased speeds. Certain surprises in this respect may be expected and it is not unlikely that within certain higher velocity zones air resistance is not increasing in the same ratio and as quickly as is the case within certain velocity limits of a lower order.

I shall herewith give an account of some observations made with regard to the destructive effects of the 7-mm. Halger-Ultra bullets striking modern armor plate with highly increased velocities while testing my cartridges with various bullets, various loads and various propellants in taking at the same time the instrumental bullet-velocities (mean-velocities) over the first 50 meters. As usual the bullets were fired against an armor plate at a distance of 50 meters from the muzzle of the rifle. These plates were about 1½ inches thick with rather large surfaces and appreciable weights. They were guaranteed by the makers to stand at least 2000 rounds of high-velocity iron-jacketed bullets. They were glass-hard on their outer surfaces, which could not be touched with a file. Their inner material was hardened rather deeply, being a special compound chrome-nickel steel which possessed a strength and hardness of a very high order. My .280 Halger-Ultra bullets weighing 9 grammes and even only 6.5 grammes, with a rather thin and soft iron-jacket and a soft *lead*-core containing but 2 per cent antimony and which were fired with an initial velocity of just about 5000 ft-sec. and from a range of 50 meters and 125 meters, smashed on the average about ⅜-inch deep into this armor plate or even somewhat deeper still in the centers of the shot holes. These shot-holes were practically circular and their diameters averaged just about 1 inch, which size of diameter was kept about constant up to a depth of practically ⅜-inch. The soft bullet material,

which during the process of penetrating into the armor-plate became pulverized and vaporized, blasted the armor-plating material out of the plate in rather large pieces around the points of impact and penetration. Rather large and circular-shaped bits of armor-plate material, which were blasted out of the plate, were found at distances of 50 to 60 yards, and many bits may have been blasted away much further. These pieces of armor torn out of the plate by the bullets possessed entirely the character of blasted shell bits and had sharply torn and serrated edges. The plate material showed at the bottom and at the circumference of the shot-holes very marked fissures and a kind of concentric layer of the material, *i. e.*, separations of the texture of the material, in spite of its great hardness and cohesion. The material at the very bottom of the shot-holes seemingly gave the impression as if a flowing of the material had been started. No armor plate of the described type could stand a larger number of rounds of such Halger-Ultra rifle shots.



Effects of Halger-Ultra Bullets on Half-inch Armor Plate.

Entry (left) and exit (right) sides of shot holes (approximately original size) made by soft lead-core .280-inch Halger-Ultra bullets through ½-inch hardened armor plate. Next to the hole on the extreme left is shown the dent made by a standard military 7.9-mm. armor-piercing b.t. bullet with special steel core. This gives a comparison of the effect of a modern steel-core bullet (velocity about 2700 ft.-sec.) with that of the high velocity type developed by Dr. Gerlich.

AS pointed out in some of my former papers, the specific critical striking velocities had undoubtedly been reached or surpassed by these Halger-Ultra bullets. Owing to the extraordinary suddenness and intensity, so-to-say the timelessness of the process, there was no interval left for the soft bullet material to collapse and disintegrate on the plate surface when striking the hard armor plate nor for the elasticity of the plate to assert itself. Indeed there was no time for the physical properties of the two bodies to show in the usual way. Even a very soft and plastic body becomes relatively unyielding when the dynamic process becomes accelerated to such a critical degree, that the time is no longer available to render possible the effects of physical elasticity and plasticity of the materials.

In the course of tests, I have also tried my Halger-Ultra bullets for demonstration purposes on a compound chrome-nickel armor plate half an inch thick, which had been used at the Testing Station for the test of steel-core armor-piercing military bullets. This modern armor plate was of very high surface hardening and could not be touched with a file on its surface, whilst its core-material was evidently of great firmness and solid toughness. My Halger .280 Ultra bullets fired from a distance of about 60 yards and with a velocity averaging between 4800-4900 ft-sec., penetrated cleanly through this plate. The shot-holes in the plate were almost circular and of an open diameter of just about ⅝ inch, *i. e.*, of more than double the caliber size. In spite of the high surface hardness of this plate the circular outer edge of these shot-holes showed on the entrance-side a slight burr while on the side of exit the plate material was blasted away on a practically circular area of about 1 inch diameter around the shot-holes to a depth of about 1/10-inch. The tougher core material of the plate was to a certain extent torn out in the direction the bullets were traveling, standing out funnel-like around the exit edges of the shot-holes. It should again expressly be pointed out, that these effects were realized by caliber .280 bullets, weighing but 6.5 grammes or just about 100 grains, and having a rather thin *soft iron* jacket and a *soft lead* core without, of course, containing any steel core or other armor-piercing devices. There is no doubt that by the employment of such Halger-Ultra armor-piercing bullets containing a special steel-core very great penetrations could be obtained quite apart from those shattering effects, which are brought about specifically by the highly increased striking velocities of such bullets themselves. The accompanying illustrations show the shot-holes of these .280 Halger-Ultra bullets through the half-inch armor plate, as described, according to the photographs of these shot-holes taken by the Testing Station.

It is evident that, for instance, shields of field-guns, the armor-plate of tanks and the like will not offer protection even against such soft core Halger-Ultra rifle bullets and will on the contrary highly endanger the crews behind them on account of their tremendous penetrating and blasting effects.

I CONSIDER it a special duty to say that the Rheinisch-Westfälische Sprengstoff A. G., Nuremberg, relying on the technical correctness of my methods and schemes and working according to my designs, has assisted me most willingly and most efficiently in the manufacture of my Halger-Ultra bullets and cartridges. It is with the greatest satisfaction that I tender my sincere thanks to this splendid firm of world-wide fame and its staff.

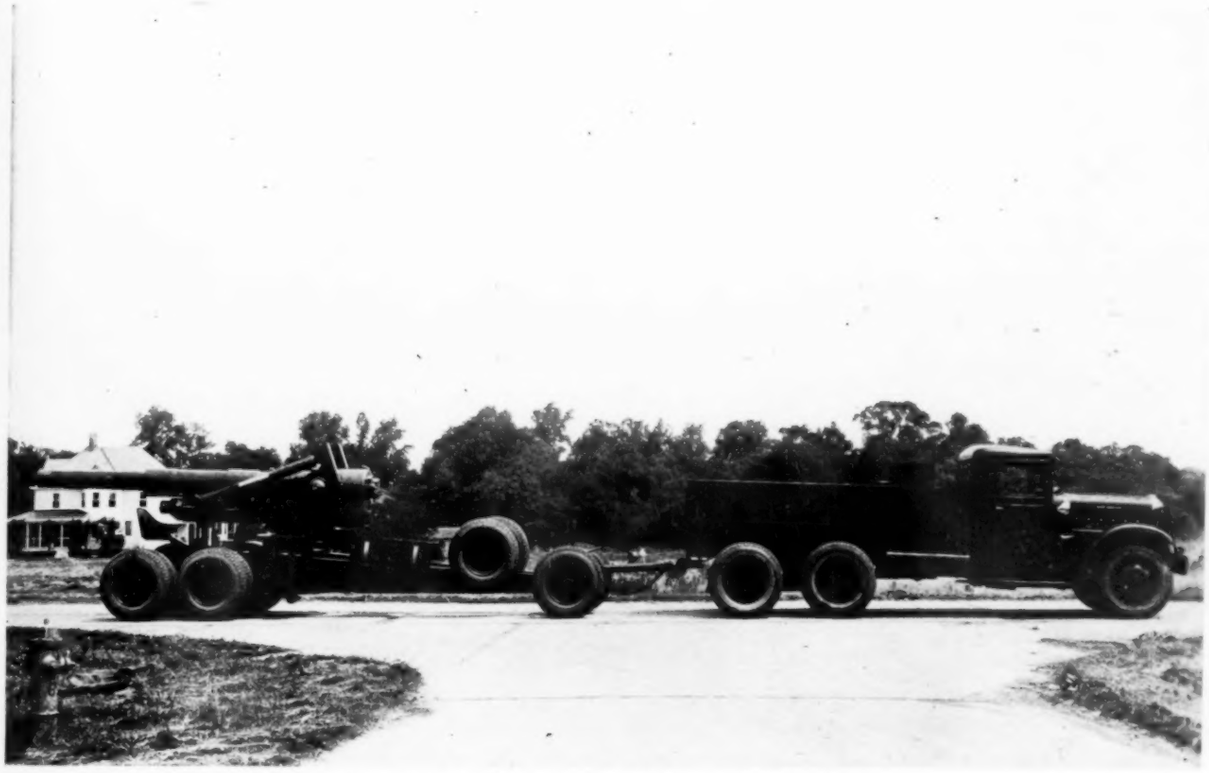
Moreover my invention may be applied not only to rifles and pistols, but also to cannon, *i. e.*, antiaircraft guns or guns to be used from airplanes, field-guns, large naval guns or extra long-range guns (similar to the German gun with which Paris was shelled during the World War from a range of about 70 miles) and probably to torpedo tubes. This conclusion is well justified by my investigations thus far.

The Latest Engineering Advancement of U. S. Heavy Artillery

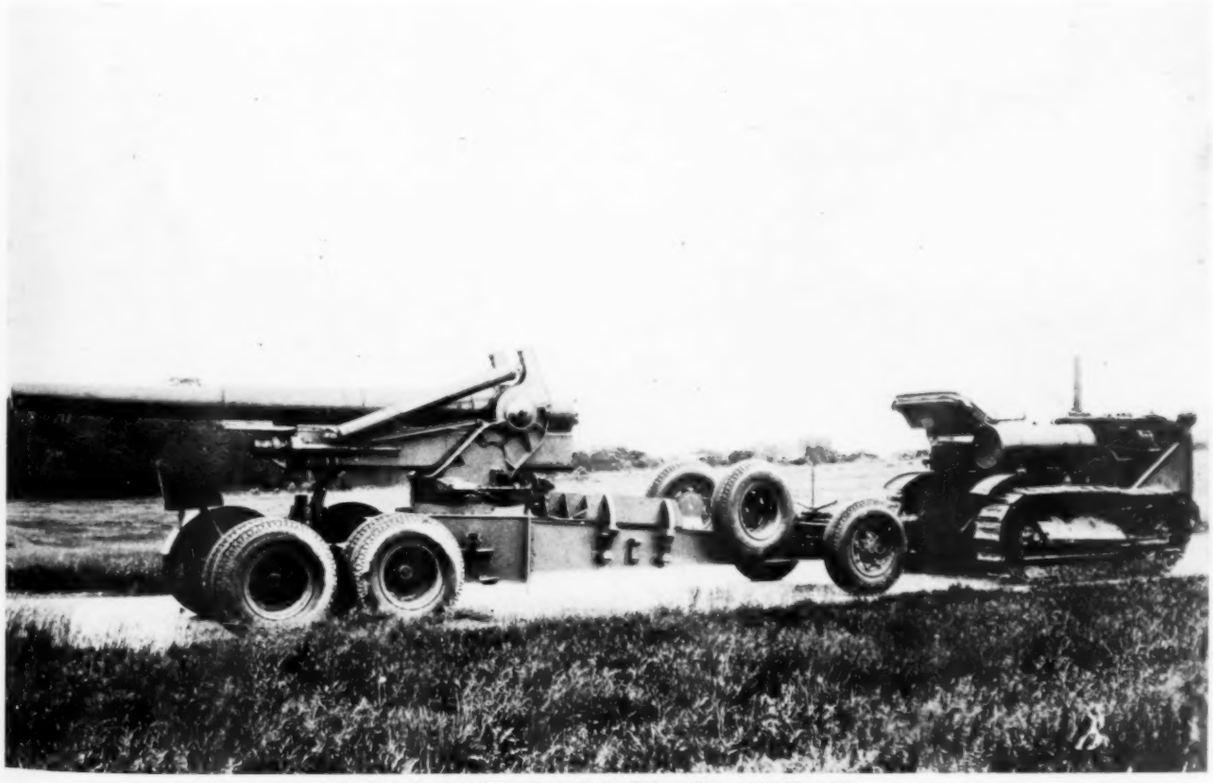
The 8-inch Howitzer Carriage, Model T2, in Firing Position.

The 8-inch Howitzer Carriage, Model T2, in Traveling Position.

The 8-inch Howitzer-155-mm. Gun Carriage, Model T2.



The 8-inch Howitzer Towed by General Motors Truck.



The 8-inch Howitzer Towed by Caterpillar "60" Tractor.

Possibilities of the Tank

Part III: Defensive and Offensive Tank Tactics

By Fred. H. Wagner*

SINCE armored cars and tanks are both a subject of the larger problem, or a mechanized force, and since the armored car will in all probability be the first to meet up with the enemy, tactics governing the use of this vehicle must necessarily be included in any dissertation on this subject.

The following statements have been prepared from a study of tactics as laid down by other countries for the purpose of presenting a picture for thought, or one from which conclusions may be reached which would fit in with any contemplated use of these necessary adjuncts of a mechanized army.

The first, and also the most important, axiom which presents itself is: *Know your matériel as well as that of your enemy. Recognize the limitations of both and do not attempt to accomplish the impossible unless the sacrifice is unavoidable.*

Armored Cars. The mission of the armored car should be:

(a) Reconnaissance. This may be accomplished by armored cars alone under some circumstances, or in company with other motorized arms or cavalry, preferably the former.

Reconnaissance in force should be accomplished by a number of vehicles all, of course, capable of maintaining the same speed. If this is impossible, the rate of advance must be based on the slowest vehicle in the unit. In Europe regulations generally call for such reconnaissance being performed by not less than one company of armored cars.

These vehicles on the march should never move in close formation, but be separated by a considerable distance, yet always in sight of each other. This will depend, of course, on the nature of the road. If the road is straight the distance between vehicles may be as much as 500 yards; if the road contains many turns, making the cars at this distance unobservable to each other, the intervening space should be shortened.

Should the force overtake a column of its own troops, it should, if possible, leave the road and proceed on the lee side of the latter; compelling marching men to leave the road often leads to temporary disorganization, and consequent loss of time. This, however, cannot be avoided if the ground beside the road is impassable for cars.

Secrecy of movement is, of course, necessary, hence the speed to some extent will be governed by the condition of the road. If the road surface is dry, more speed will entail large dust clouds which, in daylight, may become visible to the enemy and excite his suspicion, consequently and if time permits, the speed should be reduced accordingly. The return march should never be made over the same road if this can be avoided, and since the enemy in all probability will retain all main roads under close observation, these should be avoided if possible.

Such a moving column should be accompanied by motor cycle patrols to maintain command over the various units, these messengers being allotted to the tete and rear of the column.

Before starting on the mission a study should be made of such maps as are available, and a stipulated objective, depending upon the amount of fuel carried, should be set as the end of the march; concise instructions as to the nature of the reconnaissance and the character of the information desired should be issued, and the commander of the column should be given all available data regarding the location of the enemy army as well as of his own. Such a force should never carry any military documents of any character while on this mission. Should the column operate in unknown territory, the advance must be interspersed with successive halts, the terrain ahead being then reconnoitered by one or two cars before the column again proceeds.

Upon entering villages or when encountering farmsteads or isolated houses, motorized guards should be left behind to prevent communication with the enemy; this is the duty of the accompanying troops. Upon approaching the enemy the main body of the force should seek shelter and one or more armored patrols should be sent out to determine his strength and location. Such information should be sent immediately to the rear by means of motor cycle messengers, pigeons, or the quickest means possible, avoiding the use of the radio if this can be done.

(b) The rapid capture of important points at the beginning of hostilities, such as fords, bridges, passes and towns, this in conjunction with other fast-moving troops and tanks if necessary.

Such action as this may also require the assistance of some artillery provided it becomes necessary to destroy strong buildings which may be occupied by enemy troops.

Should it be necessary to occupy such towns the armored column should not be held up any longer than necessary, and additional infantry should be sent forward for this purpose as quickly as possible. Should it be necessary to destroy bridges in the path of the advancing enemy, engineers with demolition equipment should accompany the column, but demolition should be a last resource, since the bridges may be necessary for the crossing of troops following the reconnaissance force, machine gunners holding the bridgehead in the interval. The tanks accompanying the column should, if the enemy is in sight, take the head of the line, and upon the return march cover the rear of the column.

(c) Attack the enemy on flanks and rear.

Such action may lead to a pitched battle but, due to their mobility, the armored cars can be of great service in opening the action, or when first coming in contact with the enemy. However, to be of real value, the character of the surrounding terrain must be known, since ignorance of the latter may lead to failure of the mission.

It should be the duty of the armored cars to penetrate the enemy line as deeply as possible, maintaining a maximum of fire while moving, but halting, if necessary, better to concentrate their fire where most needed. This will give the in-

*Consulting Engineer. The Bartlett Hayward Company, Baltimore, Md. Colonel, Ordnance Reserve, U. S. Army.

fantry the necessary opening, the advance of the latter being covered by the most intensive fire possible. This also pertains to tanks, and if the latter have had opportunity to reach the flanks they will be in position to disorganize the enemy, and should the result of the action be favorable, all efforts of the armored cars should be exercised in pursuit.

Here the celebrated August 8th, 1918, may be again mentioned. The armored cars, where the terrain made passage under their own power impossible, were taken in tow by tanks when breaking through the enemy lines, and cast loose in the rear of the latter, where they created considerable havoc, but sufficient reserves were not on hand to follow up the pursuit before enemy reinforcements arrived.

Should the action fail, both armored cars and tanks must cover the retreat of the other troops and ward off pursuit.

It is recommended, when an attack is to be made by armored cars, and if the terrain is suitable, that they be divided into three waves, one being in reserve. If accompanying infantry, the latter should follow the first wave in conjunction with the second, while the third or reserve wave follows the infantry.

(d) To accompany the advance in a "feeling out" objective, and guard the rear in retreat.

In examining the construction of the many types of armored cars for this purpose, there is one which, in my opinion, stands out beyond all others, and that is the Skoda car which has the same appearance front and rear. Fig. 1.

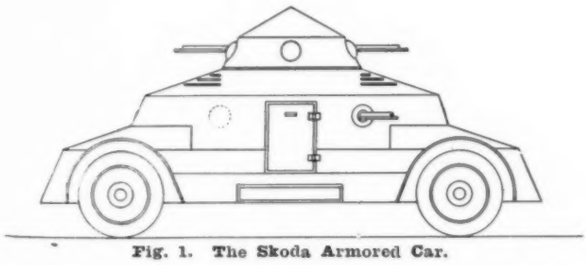


Fig. 1. The Skoda Armored Car.

This car has a weight of 7.75 tons, is 21 feet, 4 inches long, 7 feet, 3 inches wide and has a height of 8 feet, 6 inches; it is powered with a 100 h. p. motor and is capable of a sustained speed of 30 miles an hour. It carries four machine guns, two of which are in a turret provided with four ports, and the other two on the sides diagonally opposite each other. This machine moves just as fast rearward as it does forward, hence when meeting an insurmountable obstacle or an enemy too strong to pass through, it can retreat just as fast as it advanced, one of the gunners taking the rear-driver's seat. Again, its shape being the same on both ends, it is difficult at a distance for the enemy immediately to determine its direction, or which is the forward or rear end. Being symmetrical in all details permits of placing the center of gravity where it belongs, or in the middle of the chassis. Such a car lends itself to tactical evolutions to better advantage than do those usually encountered.

Accompanying the advance and acting as rear guard are two of the most important missions assigned to armored cars. If assigned to the advance they will not march directly with the column, but will precede it in waves. For example, the first car will advance with the object of breaking through the enemy line; this one will be followed by the second at a distance of about 2500 yards; then will come the support, probably a half company of cars, at a distance of say two miles, accompanied by motor cycles for the purpose of maintaining communication, and should the enemy be present in depth, the second half of the company will follow at the same interval.

It must be remembered, however, that the enemy will also be provided with armored cars, consequently the possibility of meeting the latter on the road exists, should any side roads be adjacent to the main thoroughfare, some of the cars should occupy these in order to take the enemy in flank. Should such roads not be available, and if the main road be wide enough, the second car should draw up on the first, the latter on the right and the other on the left side of the road to place the advancing enemy under fire from at least two cars.

If it is possible for the cars to negotiate the ground away from the road, it is of advantage to send the second half of the company across country to take the enemy in flank.

It is necessary at all times to keep contact with the troops when retreating, and this is best done by motor cycle. Everything must be done to prevent the enemy filtering in between the column of troops and the advance guard of armored cars, since it is the mission of the armored cars to prevent the enemy reaching the marching troops; this mission is somewhat more readily accomplished because, should an enemy armored-car force enter the line behind the troops, the armored-car guard can surround the tete of the enemy and place the latter under flanking fire.

(e) In defensive battle.

Although the armored cars are mainly intended for attack, occasion may arise when the enemy has broken through the line and it becomes necessary to stop a further advance; they can be used to great advantage here in preventing an advance and in the probability of driving the enemy back; they thus become a highly mobile reserve.

Several very interesting examples of this were observed during the World War, or when the armored cars of the French were sent forward to help close a breach in the line; they were able to hold the southern outlets from Beauvraignes and the Bois des Loges, directing their fire on the advancing enemy and preventing the surrounding of their own troops. From here they were ordered to Remaugies to cover the left flank of the Allied Army, but were met by heavy machine-gun fire and, *not being provided with dual control,* they were compelled to turn around in the face of enemy fire. They then took position between Remaugies and Onvillers, and here they halted the enemy advance. Following this, when the enemy was about to turn the French left flank at Faverolles in order to reach Assainvillers, they were thrown into the line here and were responsible for the retreat of the enemy.

TANKS in the final analysis, must be considered a weapon of opportunity, to be used when and where their power will be felt most and in such manner as is best suited to their characteristics and limitations.

Tank tactics, to be successful, must necessarily be based on two principles, that of surprise and that of rapid movement. Surprise can best be obtained by doing the opposite of what the enemy expects you to do, while rapidity of movement will depend on the character of the tank at our command. If it is possible to have the enemy believe you are about to

undertake a certain action, and if you can keep him in this belief while you launch something entirely different, surprise will be accomplished and the strike will occur where it is not expected.

The character of the implement given you to make this movement is often entirely out of your control, and you must necessarily take the limitations of your weapon into consideration when formulating your plans. For the latter, however, I feel we have a tank which will answer our purpose, since it is not too heavy to cross ordinary bridges, or if not, the engineer's equipment is sufficient to provide the crossing; it has the necessary speed and cruising radius, and it possesses effective firing power.

It is useless to break through the enemy line providing your attacking force is not sufficiently strong to deal with the enemy reserve which will be encountered behind the line; otherwise you will achieve only a local success by disorganizing the immediate line, and the good work will have to be repeated when you are strong enough to carry on. If it were possible to draw the enemy's reserves to the point of attack and then envelop them or break through, the objective will be reached and the success worth while.

The Battle of Cambrai is hence illustrative, or, quoting General Fuller, "At the battle of Cambrai * * * the initial blow could not be taken advantage of, because, though we broke through the enemy's defences, the strength of the force broken through was not sufficient to cause more than a local disorganization. The enemy's strength was not in the front line, but behind it; we could not in the circumstances disorganize his reserves. It is the reserves which always count * * *"

Proper reconnaissance by air would have made this clear before the blow was struck, consequently reconnaissance by air previous to the attack will in all probability locate the reserve and its strength and determine whether the contemplated blow may be successfully completed.

General Fuller continues: "A study of Napoleon's tactics demonstrates the fact that the first step he took in a battle was not to break the enemy's front, and then, when his own men were disorganized, risk being hit by the enemy's reserves; but instead, to draw the enemy's reserves into the fire fight, and then, when once they were pinned down, to break through or envelop them. Once this was accomplished, there was no more opposition to be expected, consequently a pursuit could be carried out, a pursuit being more often than not initiated by troops disorganized by victory against troops disorganized by defeat.

"Before the Third Battle of Ypres had commenced, we had drawn in large quantities of the enemy's reserves; this, judged by the Napoleonic standard, was correct; where we failed was that, once we had drawn in these reserves, we had no Old Guard disposable to smash them.

"At the Battle of Cambrai we struck with our Old Guard (tanks) before the German reserves were on the battlefield. It was a blow in the air, and the result was that we crashed through the enemy's front, and then, when the enemy's organized reserves were brought up, having no Old Guard to meet them, the tactical advantage was theirs and not ours—we were repulsed."

This plainly shows us that at Ypres the British lacked the means for disorganizing the enemy, while at Cambrai the enemy failed to give them an opportunity to disorganize him, consequently both battles were conceived on tactical premises which were fundamentally unsound.

General Fuller is absolutely correct in that sound tactics call for compelling the enemy to mass his reserves in a given sector, and to then disorganize these reserves before the break through. After this pursuit becomes possible.

No more alluring picture of how a tank battle should be fought can be given than the one painted by General Fuller.

Fuller assumes that the attack is to be made on a front of some 100 miles where, induced by visible preparation, the enemy has collected some four or five armies. The primary tactical objective is the zone between the enemy's army headquarters and his divisional headquarters, not the zone of the enemy's guns as was formerly the case, the latter now forming the second tactical objective.

AFTER the preparations are practically completed and without any preliminary tactical action, fleets of tanks will, at top speed during the day and also by night, if possible, proceed directly on to the various headquarters allotted as their objectives. Should it be by day, airplanes will indicate these objectives by dropping colored smoke, or by colored lights if at night. In no instance is it expected that the distance to be covered will exceed 20 miles, consequently the tanks should arrive at the enemy's army headquarters in no more than two hours. In the meantime every available bomber should concentrate from the air on the various supply and road centers, avoiding signal communications because it is highly important when confusion results from the combined attack of tanks and airplanes that this should be made known as soon as possible for its psychological effect, since bad news confuses and confusion induces panic.

This will naturally result in the giving of orders and counter-orders in the enemy line, and when this has been given time to become thoroughly epidemic, *a combined tank, infantry and artillery attack,* carefully prepared, should be launched, the objective of this attack being the zone of the enemy's guns, or a zone possibly 10,000 yards deep.

Immediately after penetration has been effected, pursuit should begin, the pursuing force being made up of all the available fast tanks and infantry, the latter in fast-moving trucks. If squadrons of tanks should precede this pursuing force for the purpose of securing all communication centers, the breaking up of hostile army group headquarters, and the dispersion of any formed bodies of troops met with, the efforts of this pursuing force will be doubly effective.

Such tank tactics will, of course, have quite some effect on the utility and employment of the other arms of the service; the infantry, to keep pace with the advancing tanks, must be carried in trucks, their employment being to assist in the primary penetration; operations in areas which are unsuited for tanks; to garrison localities reduced by the tanks, and to protect the rear echelons. This means that after the initial blow has been struck, the main duty of the infantry will be the formation of a mobile protective line behind the tanks so that administrative and other rear echelons will be secure, consequently they will become a defensive force and their principal weapon should be the machine gun.

Should cavalry be employed, it would probably be in the role of mounted machine-gunners and, providing their endurance is sufficient to permit of moving 20 miles a day for a period of say a week, they would have considerable tactical

value as battle police by forming a mobile mounted skirmish line between the tank groups.

After the first day's advance the heavy artillery will no longer be a mobile arm, but will be returned to the siege train, while the field artillery, providing it is horse drawn, will be far behind the fighting after the second or third day; this of course necessitates the substitution of tractors or self-propelled mounts for the horses.

The air force must necessarily act as protectors of the tanks, and to do this they must be assigned to act as advance guard to tank operations; to give the tanks every assistance in disorganizing the enemy's headquarters; to act as guides for the tanks; to protect the tanks from hostile artillery; to maintain communication between the tanks and their base; to provide the advanced tanks with fuel, supplies, ammunition, etc., and to carry the tank brigade commanders above their sectors of operation during the battle in order that they may visualize these operations and throw in any reserves where necessary.

The engineers will be confined chiefly to improving communications, roads, railways, building bridges and repairing others.

The service of supply, to keep pace with the advancing forces, will be motorized, and the trucks so employed should be of such character that they can negotiate rough ground as well as roads.

THUS we have a mechanized force in being; however, we also have an illustrated example of history by which to measure such a surprise tank attack, an example to which I referred in my first article.

It was on the morning of July 18th when Foch launched his heavy blow for which the Xth and XIth armies had been secretly concentrated opposite the left wing of the German VIIth army. The attack of the Xth French Army was covered by a mass of 324 light and heavy tanks, and 225 of these succeeded in getting into action; of these 102 were casualties, almost 50 per cent, the enemy artillery accounting for 62, or 60 per cent of the total tank loss, while the tank personnel loss amounted to 25 per cent of the effectives engaged. As to the second day's fighting we find the losses were even greater, or the 3rd Heavy Battalion lost all but two of its remaining tanks, only one reaching its final objective. Fifty of the 105 tanks operating on this day were hit. During the following days, according to General Fuller, in "Tanks in the Great War," only small local attacks were attempted in which 32 tanks took part, and here we find that 17 were hit, or 53 per cent, while the personnel loss amounted to 52 per cent. July 21 saw 100 tanks engaged and here 36 were hit, another 30 per cent, while on the 23rd the tanks were supported by two French Army-corps, and the loss amounted to 48 tanks out of a total of 82, or another 58 per cent.

How far will the Army, in the picture of a tank battle painted above, proceed with such stupendous losses? Unfortunately these truths are rarely presented to the attention of newspaper readers, otherwise the tank propaganda would probably not have made such excellent headway, especially in England; all they were given to read was a story about "a swiftly moving steel-clad monster, itself invulnerable to the enemy's shot and shell, mowing down German infantry and gunners like corn." And remember this was a surprise attack planned by Foch, and yet their losses "far exceeded the percentage of losses which they inflicted upon the enemy!"

In this case the tanks were operating under just the ideals demanded by the tank enthusiasts, a part of one of the greatest surprises related by history, planned, as stated above, by a "master in the art of war," a master who had known how to concentrate an overwhelming force of infantry, artillery, aircraft and tanks at the most vulnerable point of the enemy's line, or where the German IXth army was on the western face of the salient at Chateau Thierry, with the VIIth on the southern and eastern faces reaching almost to Rheims; they had made no attempt to either consolidate or fortify their line; they were flushed with a victory which made them scornful of the enemy; they were on the march to Paris. Supreme German headquarters had been advised of the contemplated attack, but they lacked belief in it.

Consequently the French were pitted against infantry and guns taken by surprise out in the open, in thick cornfields which limited their field of fire and gave them no protection.

Here is where the Renault tank got practically its first baptism of fire, a tank which was much speedier and which presented, on account of its size, a much less conspicuous target than had any of the previous tanks.

In spite of all elements being in their favor, *"the tank-arm purchased such successes as it gained by a percentage of loss so appallingly high as to threaten the utter extinction of this arm in a short period of fighting."* The tanks in this battle suffered a percentage of loss which exceeded the percentage of loss suffered by the accompanying infantry and artillery.

The question naturally arises as to how it is possible for the student to accept the usual assertion that such a frightful decimation of both tanks and crews was a necessary element to the success of Foch's plans when it is remembered that at Cambrai, on May 27, the German success in surprising and causing the rapid retreat of the Allies was just as great, and the Germans had no tanks at their disposal.

Here let me quote Germains, "How can we seriously accept the theory that all the genius of Foch, all the vast skill of the highly trained French staff, all the valor and dash of the superb French and American infantry, all the magnificent élan of the French gunners, all the chivalrous daring of the French and American airmen, went for nothing in comparison with the presence of two hundred and twenty-four machines, one half of which were shot to pieces or otherwise knocked out of action in the very first day of fighting!"

Hindenburg says "our infantry left the battlefield in no way with the feeling of having been vanquished * * * the feeling of helplessness against the enemy's tanks had to some extent been overcome. Our men had often made audacious attempts to lay low this troublesome foe and had been lustily supported by our own artillery. Once more the French artillery had been responsible for the worst crisis with which our men had been faced."

What now becomes of the excuse "We were not defeated by the genius of General Foch, but by General Tank"? German pride no doubt likes to believe this slogan, but it is not true, since Hindenburg is of the belief that the French artillery was far more destructive of infantry morale than was the tank, and after the employment for hours and even days of the French artillery, "the approach of the enemy's storm troops had often been regarded as a release from the menace of inevitable destruction."

THE tank attack formation shown in Fig. 2A is well dispersed and can deliver the maximum of fire, the foremost tank being the point of the thrust, but the formation shown in Fig. 2B allows of too much concentration and depth. Fig. 2C shows a broad front, but less depth. Fig. 3 shows an attack on an unlocated antitank gun, the tanks passing to right and left in zig-zag courses from the direction of fire in order to envelop the gun. Fig. 4 shows the tanks with better cover, the main body of the group turning to the left, while one tank, with less cover, is attempting to pass to the right, both lines aiming to envelop the gun. Both of these methods are excellent. Fig. 5 shows an attack on trenches, the tanks in each group being properly separated, but all in position to direct

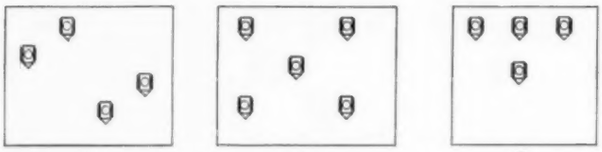


Fig. 2. Tank Attack Formations.
A. Well dispersed, the foremost tank being the point of thrust; B. Too much concentration and depth; C. A broad front with less depth.

their fire on the enemy. As regards tank against tank, this will be a matter of circumstances, depending on the enemy formation, but every endeavor should be made to fire on the flanks of the advancing tanks.

History is, no doubt, the best foundation upon which to build the future, but in this case we have no history to study since there were no battles during the recent war in which large fleets of tanks came in contact with other fleets of tanks. We may surmise, assume and suppose *ad infinitum,* but theorizing will be of no avail when we are actually precipitated into such a battle, and the experience there gained will be our only basis for the sound development of tactics.

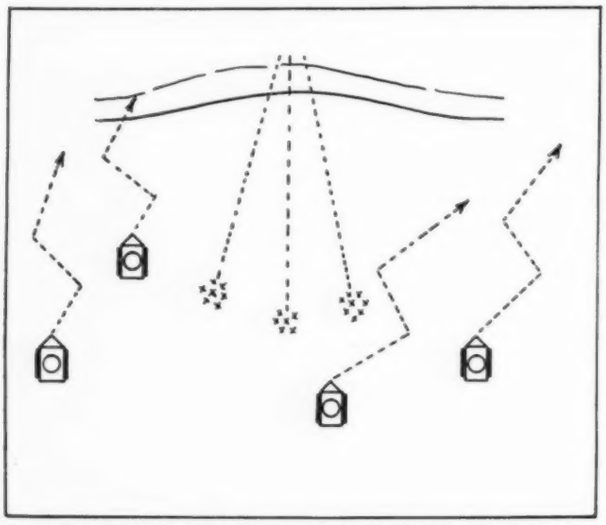


Fig. 3. Tank Attack on an Unlocated Antitank Gun.
Tanks passing to right and left in zig-zag courses from direction of fire to envelop gun.

IN rear-guard actions a mechanized force can be employed to excellent advantage, and its possibility of success will be enhanced provided the tanks are accompanied by airplanes, armored cars, speedy tractor-mounted guns, mountain artillery of such size that it can be handled by men, infantry and engineers in speedy and dependable trucks, and cavalry.

The information for the use of the commander of such a force should embrace knowledge regarding the enemy's numbers and distribution, as well as the location of his own troops, and the terrain over which the action will take place. The airplanes can reconnoiter the ground as a whole, but

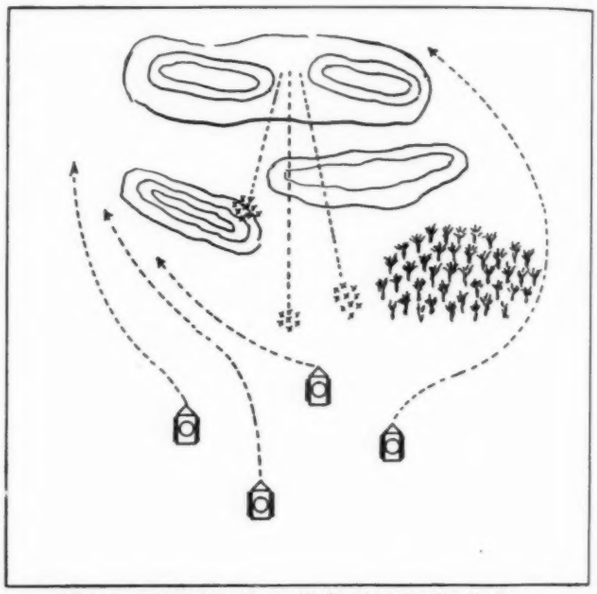


Fig. 4. Tank Attack on Unlocated Antitank Gun.
Main body of tanks turning to the left, one tank with less cover attempting to pass to right, both lines aiming to envelop the gun.

where its eyes cannot penetrate the cavalry must be used, not to attack the enemy, but to reconnoiter the ground, such as woods, or where the aviator cannot see.

It must be remembered that suitable ground for both tank and motorized artillery is somewhat limited, hence this force should not be larger than the terrain will permit of bringing them all into action. The tanks should be in such location

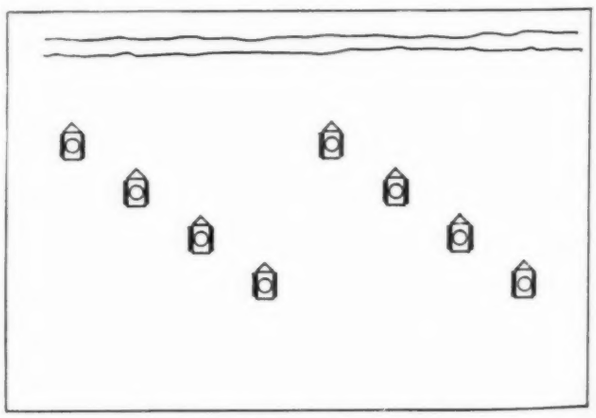


Fig. 5. Tank Attack on Trenches.
The tanks in each group are properly separated yet all are in position to direct their fire on the enemy.

that they can strike the enemy's flanks, hence the terrain must be definitely known, and the Army commander, who never definitely knowns whether he will win the battle or not, should have the ground, where he expects to deliver a rear-guard action in case of defeat, reconnoitered either before or during the main battle.

Definite instruction should be given as to the ground to be

occupied by the tanks and the artillery, and that to be occupied by the infantry, the latter being left open for the passage of the infantry moving to the rear, the roads being left open, if possible, for the movement of vehicles. As soon as the retreating troops have moved out of the battle area the guns should occupy the frontal positions assigned them, with the tanks on the flanks; the duty of the artillery is to hold the advancing tanks and other armored vehicles of the pursuing force, while the tanks will attempt to reach the flanks; or the latter will proceed in an attempt to lure the enemy tanks into a position where the guns can reach their flank. In this manner the guns will form the base of action in the first case, and the tanks will assume this base in the second case.

This requires that the terrain not open for tanks must be guarded by deployed infantry, the latter being plentifully provided with automatic rifles, heavy machine guns and mines, thus being in a position to inflict damage on any stray enemy tanks which might attempt to take a chance over such country.

Should the terrain be open, or one which is suitable over its entire expanse for tank movements, the latter should not be dispersed, but concentrated in strong groups, leaving the artillery to occupy a front as wide as is tactically advantageous. In this case the artillery will be in position to keep the enemy tanks at a distance, thus giving the tank groups an opportunity to maneuver for attack. The action will thus be brought on and, while this is taking place, the cavalry and engineers will be somewhat to the rear where they will reconnoiter the terrain and be prepared to demolish such structures as will impede the enemy advance should the latter break through. The position of the armored cars will be well on the flanks and they should attempt to reach the enemy's rear.

Should the action take place in hilly country, the terrain will again be one in which the tanks cannot maneuver at will, since their field of action will vary in width and at times may be extremely narrow, thus making the flanks of both tanks and guns quite vulnerable, especially should the ground be so rocky that they cannot cross it. Should the enemy be in force on the hill sides and be accompanied by mountain artillery, the latter may destroy the tanks, or if not, the tanks may become stalled and subject to capture by the infantry. In such case the flanks must be protected by infantry and mountain artillery for the purpose of driving the enemy infantry from the hills and to attack his motorized forces which may be located in the valleys. Besides this, infantry is not influenced by the nature of the ground as are tracked vehicles, consequently the closing of defiles and the demolition of bridges will cause serious delay to the latter. It may be even necessary to sacrifice some of our own vehicles, since a broken down heavy tank in a defile will cause a delay of hours to the advance of a motorized force.

Should the terrain be crossed by rivers or deep streams the tracked vehicles will be at a distinct disadvantage, for they cannot cross these at present; this is why tanks must be given a weight which will not over-stress any bridges which might be used for the crossing. In such case the infantry should occupy the river bank while the tanks and the artillery should be located in groups, in the rear of the infantry, but in such position that they can deliver flank fire on any possible crossings. Should the enemy force the passage, the infantry should retire while the artillery should take position which would permit of frontal fire on the enemy which has crossed, while the tanks take up their normal flank attack. This action is also subject to two cases, or the tanks may take up the frontal fire and the artillery that on the flanks.

When the country is wooded the tanks will find difficult or impossible passage, but the woods might be used for establishing an ambush, or should the woods be occupied by infantry the tanks may encircle it and prevent a retreat. This requires that the infantry in the woods be supported by artillery, located in the woods if possible. Where several woods cover the ground, tank groups should be established on the ground between them, thus being in position to attack any hostile vehicles which may have been driven away from the woods in front.

Difficulty will be experienced when tanks are sent to take villages or towns, since obstacles can be prepared here which will prove almost insurmountable for tank advance. In holding a town or village the outskirts should be picketed by both infantry and field artillery, in which case the tanks should be concentrated in groups at several central points, depending on the size of the town; where there is more than one group the central one can be employed in clearing the streets, while the other groups can be used for flanking operations against the enemy. Should a retreat be in prospect, the tractor-mounted artillery should be grouped outside and on the flanks of the town in order to protect the line of retreat.

DEFENSE against these implements of warfare may be divided into two classes, or passive and active defense, and combating armored cars is relatively a lighter matter than that of tanks.

The maneuvering ability of the car, unless it has duel control, is limited, and it may be easily stopped by means of obstacles; it is lightly armored and rifles with special ammunition can play havoc with it. The appearance of armored cars on the road is a signal for marching troops to leave the latter, and villages and forests offer excellent opportunities for defense.

Ditches beside the road may be used to lie in and be free from the car's fire, since the guns of the latter cannot be depressed sufficiently to reach the target; this gives the infantryman plenty of time to open fire with his special ammunition. Hand grenades are even more effective in this situation. Cavalry, however, when encountering a car on the road, can only disperse in the fields or woods as quickly as possible, but not with the same degree of immunity, since cavalry presents a better target.

Marching troops should never proceed on a road without an advance guard; the latter can signal the approach of cars by rockets or other means, upon which signal the troops will immediately leave the road. Large bodies of troops will be provided with weapons more suitable for car or tank defense, and some of these weapons should be assigned to the tete of the column.

Troops halting for rest should always select a spot where the terrain naturally offers some protection, but should such natural protection not be available, the troops should be dispersed as much as circumstances will permit.

The question as to whether fire shall be directed against the driving gear or motor, or the crew is debatable. Some instructions call for fire directed upon the crew, for when they

are out of action the car is worthless. Owing to the relatively thin armor and the usual lack of protection for the wheels, the car is highly sensitive to the action of hand grenades; this will stop the car and the crew can then be more readily taken care of.

Flame throwers are also employed against cars as well as tanks; this also pertains to lethal gas. Most cars are provided with open gun ports, and these should be the target for flame or gas.

For passive resistance we find tree boles across the road very efficient in the case of cars, and if these boles are built up into a barricade and laced to two opposite trees they also offer quite some resistance to tanks, compelling the latter to leave the road, consequently barricades are most efficient where the surrounding terrain will not permit of car or tank operation. This applies to sunken roads, heavy woods on both sides of the highway, in villages, etc. If such barricades are under the fire of antitank guns the result will be devastating.

If tree boles are not available, wire rope or chains stretched between trees will answer in the case of light tanks, or several coils of barbed wire in the case of cars. Ditches, say two feet deep and three feet wide, dug across a road are highly dangerous to speeding cars, and these should be hidden as much as possible, the ditch being covered with light twigs with some of the road material spread on the upper surface, all superfluous earth from the ditch being removed from sight.

On roads cut into the sides of hills, or where the car cannot leave the road on account of the hill on one side and a steep declivity on the other, large boulders strewn on the road will suffice to stop an advance; these boulders should be placed over a distance of say 25 feet with intervening spaces of about 24 inches. A few men with hand grenades on the hill side above the car or tank can readily complete the destruction, the tank on its track can, however, negotiate these boulders in time, but the delay may be dangerous.

Weighted wagons stretched across a street in a village will be effective; they should be tied together in order to prevent the car pushing one aside, or a wheel may be removed from each wagon for the same purpose.

Tank traps, such as deep, wide trenches with almost vertical walls are effective, but they must be effectually hidden; this can be done by building up a mound of earth, on the approach side, about three feet high and seven feet wide, and by giving the reverse slope a descent from the crown to the ditch; the angle of this descent must be such as to insure the delivery of the tank's front wheels into the ditch.

Tank mines may be stretched across a road, or they may readily be hidden in grass.

Barbed wire entanglements are not effective against tanks, but when built in a certain manner they are effective against the following storm troops. Examples are at hand where such a barricade, after a Renault had passed over it, bobbed up again to two-thirds of its original height. The posts carrying such wire may be specially prepared to further this action, but care must be taken to anchor them firmly, otherwise the tank will carry them away.

In siege warfare the tank forts proposed by the Germans, and illustrated and described in my first article, may be employed. Gun against tank is still the final answer; the above methods may put a few out of action, or they may delay others, but finally unless artillery of armor-piercing ability is directed against the tanks the latter will proceed on its mission of destruction.

This fact alone will make a new distribution of weapons necessary, and special guns must be assigned for tank defense only. These guns must, however, be manned by expert gunners, because their target is a relatively rapidly moving one, and all the practice one may have against stationary targets will be of no avail in this instance.

England, as we know, is given whole heartedly to tanks and mechanization, and while France is not quite so enthusiastic about mechanization, care is being taken to be prepared for all eventualities in the matter of tanks. Germany, it appears, has little fear of the tank today, since it is claimed that defensive methods have probably been developed which will counteract tank offensive. What these methods are remains secret, but no doubt the development of the thermite shell is bound up with it; should, as stated before, such a shell register on any moving part, the tank will cease to advance, and will then be at the mercy of the guns, for it will have become a stationary target. Surprise must be guarded against, since a complete surprise will account for 75 per cent of the victory.

I cannot agree, as you have no doubt noticed, with all that General Fuller has written about tanks, but great credit is due him, through his lessons taught by experience, for a thorough exposition of tank tactics, bearing in mind the limitations of the weapon at present at our command.

At this point I wish once more to recommend the late Major Fritz Heigl's "Taschenbuch der Tanks" to your consideration; the data contained are valuable, and their perusal will be of advantage.

IN closing this article, I will ask you to look into the future with me for a few moments, using history for our text book. According to the maxims of our tank enthusiasts we are presented with a picture which depicts success in future wars as gained by some marvelous mechanical invention, surely not without leadership of the highest caliber, but without large armies or hard fighting. This picture assumes seriously dangerous proportions when presented before a nation (witness the exhibibtion of the "spectacular tank" in England and its results) which has but little love for the expense connected with maintaining an army, however small, considering the latter only a necessary evil which must be endured, and which our pacifists, who are growing in volume daily, would throw entirely into the discard. Why an army of trained men when our industrial organizations are capable of turning out mechanical implements of warfare which can easily dispose of an enemy with the aid of a few men? Is our next war going to be with the Republic of San Marino mentioned previously, or will it possibly be with another highly industrially organized nation?

The art of invention never remains dormant, it is always alive in the minds of some people, and this holds true for implements of war as well as those of peace. Witness the very interesting experiments now going on with Major Nagayama's small, distant-control tank in Japan. This tank is about 10 feet long, carries one machine gun, also operated by radio, and which at present has a speed of only 5 miles an hour. What will be the speed two years hence? This tank carries no crew, consequently to carry on our theme

ad absurdum it is only necessary to picture several thousands of these robots let loose on an opposing army. We saw above what happened to tanks with human brains to guide them; what will happen to these wasps under distant control in the thick of battle? This, however, shows that inventive minds are not idle, and we cannot picture the character of tank of say twenty years from now.

Providing any future war is with another industrialized nation we can expect to find the opposing inventors to have been busy also, and what will they place in the field? But this is not at all necessary, as witness the recent purchase of 40 Medium Vickers and 20 Carden-Loyd Mark VI tanks by Russia in England. One country alone does not, however, possess all the inventive genius, and the enemy's people are not all fools.

Let us assume we have built a required number of the best tanks our minds can conceive. What will we do with them? The tank crews must be trained. That is comparatively easy as regards operation in peace-time maneuvers, but what will they do in actual war to bring about the victory of prophecy, and how will an army be trained to take advantage of this new implement? We can do all that man is capable of during peace, but when war comes the result will be in the laps of the gods. This question can again be answered by only examining what the past has to teach us.

We are told that tanks were tested at Aldershot in 1907 and 1908, "but the military authorities could not see or foresee their use." This was peace time, but we now turn to war, and here we find that it required three years of actual warfare, or from 1915 to 1918, to remedy defects and produce a tank which was of any real value.

How many years will it now take to produce a tank worth having for a future war? How will training be accomplished if enemy shells are not zooming over our heads? Remember that in 1918 the British Army was in possession of a large number of tanks which had passed through three years of travail before they were "worth having," and yet this same army was attacked and defeated by an enemy which possessed practically none of these newer implements, and when the tanks were victorious (?) the loss in men and matériel was appalling.

I HAVE often stated in these articles that surprise is the very essence of success. Let us again assume we have the tanks and that we are attempting to train an army to act in conjunction with them. Can this peace-time training be kept secret with the usual American newspaper hound on the scent? And if not, where will be the surprise which we will be able to spring on an unsuspecting enemy, except perhaps in the approach itself?

For the necessity of this training we have as a witness General Monash, who tells us how he insisted upon intensive and long training of tanks in conjunction with his Australian infantry, and how he made arrangements for veiling the approach of his tanks, and how this advance was to be covered with a rolling barrage of gun fire. Again, General Fuller insists upon training infantry in conjunction with tanks. This, however, had to be done in the stress of war, and the only lessons learned were through painful and bitter experience.

Livesay tells us "at present the tank once started, is a law unto itself, and too often becomes detached. In the darkness and fog of the early morning of August 8th, they often lost their way, over-running their objectives or missing them altogether. Compasses were useless because of the mass of metal and, shut in that fiery box, a general survey is impossible. One tank was observed coming back from the front line when its commander supposed he was working forward. . . . In many cases they sailed right over dugouts and past machine-gun posts they could not see in the mirk, so that our infantry following up had a hard time of it. . . . Tank crews, indeed, were under a terrific strain, both physical and mental. . . . In that confined space, filled with poisonous gases, the atmosphere was all but insupportable. Tank crews have been known to come out of their fortresses and throw themselves on the ground in utter exhaustion amid the full fury of the enemy's barrage. A full day's battle such as August 8th, played them out, and there was great difficulty in getting the tank crews into shape for the battle of the following day."

It is a wonder that under such circumstances the tanks performed as well as is recorded, but other circumstances entered this result and for which the tanks were not responsible.

This picture is completed by Germains, who says "Picture the plight of the staff officer asked to work out the approach marches for these unwieldy jibbing monsters, and with absolutely nothing on which to base his calculations; picture these columns of tanks straying all over the country, tying themselves up with columns of guns and infantry; picture the lurid cursing and hopeless muddle it would have meant. Out of 500 tanks we should have been very lucky indeed if one-third had reached their battle positions in time to take part in an attack, and once the surprise had worn off the Germans would soon have rallied. If the Battle of Cambrai, planned by a very able staff possessed of an improved form of tank, and upwards of a year's experience in tank fighting, ended in a disaster, how can you imagine that an attack a la Mr. Winston Churchill would have been a success?"

This was in answer to Mr. Churchill's bitter comment on the *premature* use of tanks on July 15, 1916, or "to achieve this miniature success, and to carry on the education of the professional mind one stage further forward, a *secret of war* which, well used, would have produced a world-shaking victory in 1917, had been recklessly revealed to the enemy." (The italics used in this reference are mine.)

THE tank was developed to its 1918 perfection during a period of war, not peace; its lessons are open for all to study, consequently I must ask whether any campaign in history and which ended in a rapid and overwhelming success was fought to a conclusion through the medium of any implement or means which had been evolved in secrecy and kept secret during the preceding years of peace?

Limited success has been gained on occasion by surprise due to some new and novel weapon, as is also attested by the use of gas and tanks in the recent war, but this success was soon neutralized when the characteristics of this new implement became known. This leads to the question whether mechanized armies, not minor mechanized forces, will be able to produce a definite decision in open warfare, or a war of movement, and Germains rightly asks whether strategy will dominate the machines, or whether the machines will dominate strategy, and he illustrates the seriousness of

this great dilemma by the following historical example.

"No two states ever adopted the principle of *mechanization* in its naval application more whole-heartedly than Great Britain and Germany in the last war. The result was that having developed this formidable array of dreadnoughts, superdreadnoughts, and battle cruisers, the fear of losing them paralyzed strategy. At the outset of the war, when vigorous offensive by the German fleet might have produced incalculable results, action of this sort was vetoed by the Kaiser. These ships had cost such enormous sums, they were so difficult to replace, that the German Government dared not risk them. In other words it was the *machines* which dominated the men, not the men who dominated the machines! But turn to the other side and we see precisely the same thing! Jellicoe, at Jutland, was admittedly dominated by the thought of avoiding loss. It was his considered policy to minimize risk, and only to engage the enemy decisively under conditions which made victory *certain,* a thing which seldom or never happens in war. When we have equipped our armies and air fleets with costly, highly elaborated super-tanks and super-aircraft, is not there danger that the same thing will happen on land? That air fleets and super-tanks will eye one another up and down like a bellicose bow-wow, and a pugnacious pussy, flourish their tails, and go home again? In other words, will you risk your all in one throw of the dice without an absolute assurance of victory?"

Let us look into the case of two industralized nations facing each other, with the picture drawn by General Fuller of a tank attack on a front *100 miles long,* or say a stretch of ground from Baltimore to ten miles beyond Philadelphia. Sit down quietly and figure out the problem of secrecy, approach, fuel, supplies, ammunition, etc. for this mechanized army, and when this army is finally ready to break loose and over-run the surprised enemy you perceive an army similar, or perhaps superior, to yours leaving the enemy lines and approaching you at a speed of say 20 miles an hour. I will have to leave the result of such an engagement to your imagination.

Will this one battle end the war, or after both mechanized armies have annihilated each other will we not resort to the now despised other arms of the service, or if these no longer exist, or if they are no longer trained to operate without the tank to help them, will we resort to fists, feet and teeth, like the prehistoric cave man, or will we resort to the use of cudgels and cythes with which the carles and serfs attempted to repel the Vikings of our seagoing-tank fable?

Mechanization of an *auxiliary force* is without doubt of extreme value, and it can be employed for obtaining various gainful results, but the brunt of any fighting will still have to be laid on the shoulders of man and gun will have to answer gun.

We speak of building tanks with speeds of 40, 50 or 60 miles an hour. What assurance have we that we will have an opportunity to use such speed in actual warfare, except perhaps to get out of the mess when it gets too hot for us? Do not permit the enthusiast to carry you away on his cloud of surmises and assumptions, but examine these projects in the cold light of reason.

The British enthusiast will tell you that the Battle of Amiens furnished convincing evidence of the supreme tactical value of the high-speed tank, and post-war tank design in great measure contemplates sacrificing protection for speed since we are told that tank immunity varies with the square of the speed divided by the height of the target. Does it? And where are we going to exercise this speed?

ARE any battles we are to fight in the future on our own soil to be fought out on our western plains, where perhaps high speed may be of some value, or is it not more likely that they will center around our industrial region with its many villages, towns and cities, the terrain of which is cut through by many deep rivers and other water courses, besides ravines and forests? What will our 60 miles avail here? And if we sacrifice armor for speed, will this speed give the tanks the desired protection? This is debatable, because it is doubtful when and where this speed can be put to use.

We will assume such a fast-moving force approaching a broad stream. The enemy on the other bank knows of our coming if by no other means than by sound-ranging instruments. A frontal attack by this mechanical army would be suicide, even though the tanks were of the sea-going variety. Artillery would wish for no better target than such an advancing force of vehicles, and if the latter were compelled to cover the engineers while building a bridge, the matter would be worse. This would require a superior artillery force, also able to travel 60 miles an hour, to silence the guns on the other side. How many batteries would have to accompany our fast-moving tanks to accomplish this? Most certainly enough to make such a composite force very unwieldy and highly vulnerable to air bombing. Should a large force of infantry accompany the tanks, in 60-mile an hour trucks, for the purpose of forcing a passage by the usual methods, this again would require quite some artillery support; and after they have been successful in forcing the passage and forming a bridge-head on the other side, they may certainly be subject to a counter attack before their own tank support can cross to them. Here again the infantry force would possibly be so great in relation to the tanks that the mobile hitting force would probably suffer.

Such examples might be cited for hours, but they lead to nothing. Wars between two highly industrialized nations will probably end in stalemate after one or two pitched battles between the opposing forces of robots, and the trenches will again result. In such wars these nations will no doubt work out additional novel weapons, and by the time the war is over their use will be fully recognized, as was the use of the tank at the end of 1918, but counter measures will also have been devised.

My thought in preparing these articles was only an endeavor to provide a subject for discussion, and in this I trust I have succeeded; this especially because in future wars I feel that lethal gas and aircraft will play such a prominent part that mechanized armies will have but little opportunity to face each other for very long without the protection offered by antiaircraft defense.

In view of all I have said, we should study the tactics we expect to employ with a mechanized force, remembering at all times that we would probably have the same kind of force in the enemy camp. Train the other arms of the service to coöperate with the mechanized force, but do not fail to also train them in the art of war prevalent before the advent of the thought which brought forth a mechanized army. *(Part IV will be published in the November-December issue.)*

Antiaircraft Gun Control

Part III: The Sperry Computer and Gun Control System

By Roswell H. Ward*

THE first essential in the operation of the Sperry computer is the acquisition of all data needed to predict the future position of the target and to compute the corrected ballistic data and resulting gun angles.

The most direct and important data—the present course and altitude of the target—are obtained by two tracking telescopes on the computer itself, one following the target in the horizontal plane and the other following it in the vertical plane. These two telescopes also transmit the angles of sight of the target to a stereoscopic height finder stationed near the computer, thus insuring that the operators of the height finder will keep it trained on the correct target. The height finder in turn electrically transmits the height of the target back to the computer. Also, the necessary data on wind velocity and direction, muzzle velocity, and other allowances which will be outlined later, are set into the mechanism of the computer by graduated dials.

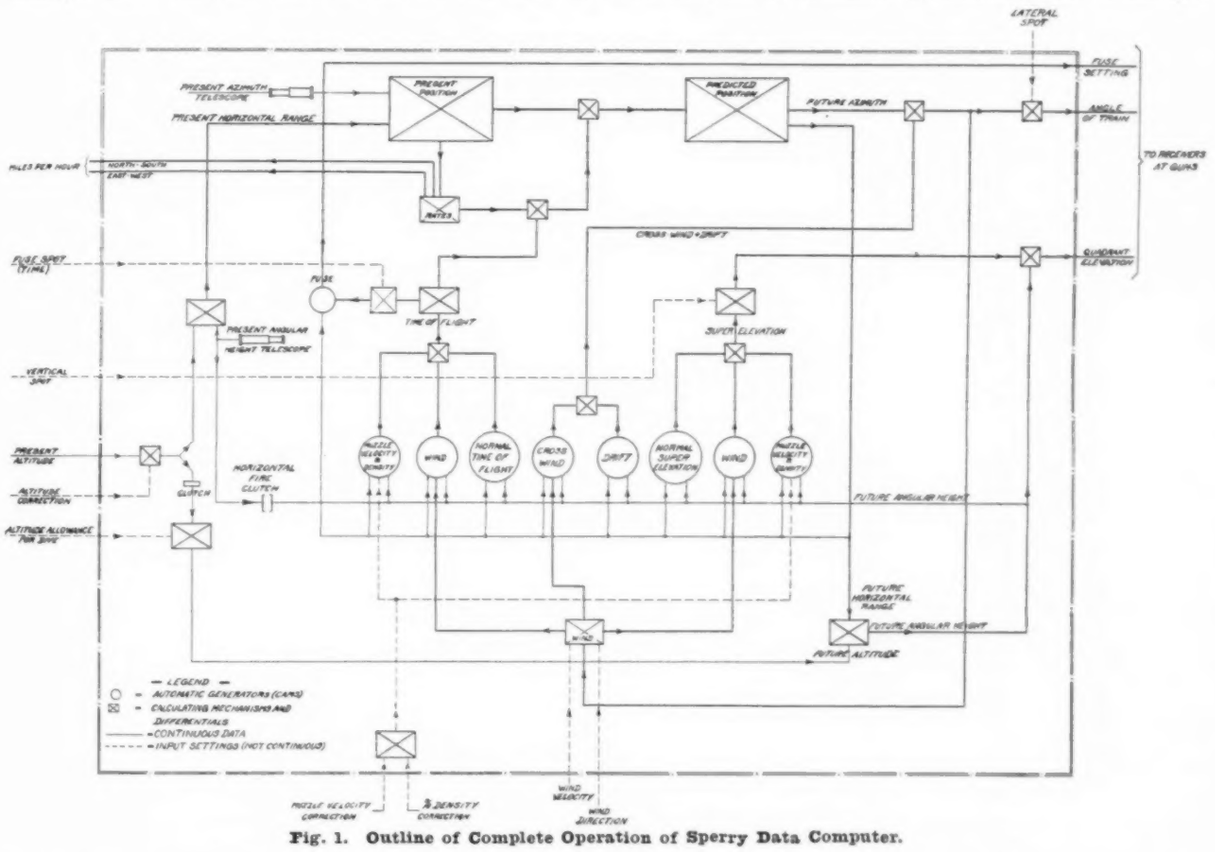


Fig. 1. Outline of Complete Operation of Sperry Data Computer.

Summarizing all of this initial "data-finding cycle" of the computer's operation, we find that the basic data are obtained as follows: (1) Present azimuth, obtained by direct observation with azimuth telescope; (2) Present angular height, obtained by direct observation with elevation telescope; (3) Present altitude, obtained from height finder—which is trained by above telescopes; (4) Wind velocity and direction, set into computer by operators who obtain data from meteorological unit; (5) Muzzle velocity, set into computer according to data ascertained by battery commander; (6) Correction for "dead time" to set fuze (if desired), set into computer by operators; (7) Correction for vertical spotting, set in at discretion of battery commander—either after test shots or as a result of observation of bursts in actual firing; (8) Correction for lateral spotting, set in as above; (9) Altitude correction, set in as above; (10) Altitude allowance for dive, part of duty of battery commander who is in a position to anticipate movements of target; (11) Air density, set in at discretion of battery commander.

With this outline in mind (see also Fig. 1) one can visualize the telescopes of the computer and the height finder being trained on a moving target, all the other data and corrections set into the machine, and the operators in a position to act as manual "servo-motors" to set various data back into the computer by matching dials.

1st Prediction Cycle: The movement of the tracking telescope indicating the present angular height of the target is transmitted to a horizontal range cam, similar to the ballistic cams. This cam is rotated according to the present

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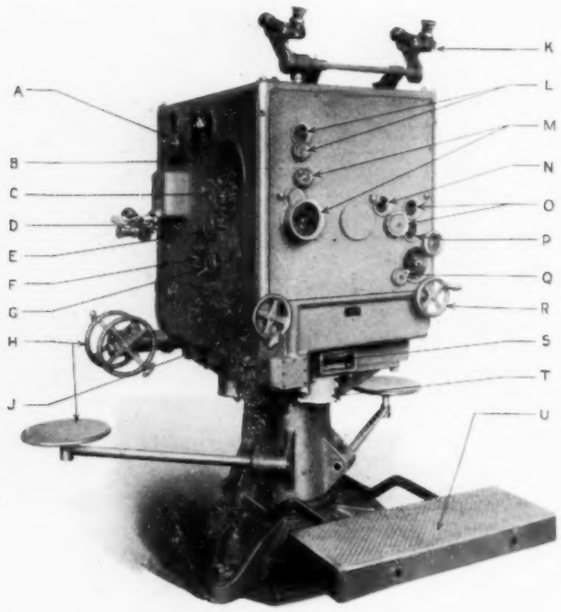

Fig. 2. Rear View of Complete Computer.

A, East and West rate dial and handwheel; B, Future azimuth dial; C, Future angular height dial; D, Elevation tracking telescope and headrest; E, Wind azimuth dial and handwheel; F, Wind velocity dial; G, Future azimuth handwheel; H, Elevation tracking handwheel and operator's seat; J, Future angular height handwheel; K, Spotting 'scope; L, Present altitude spot and handwheel; M, Future altitude spot and handwheel; N, Fuze time spot handwheel and dial; O, Vertical spot handwheel and dial; P, Lateral spot handwheel and dial; Q, Muzzle velocity and air density handwheel and dial; R, Future horizontal range handwheel; S, Spirit level; T, Data transmission cable plug receptacle; U, Fire-control platform.

angular height of the target—and has its cam follower positioned by the present altitude of the target—as received from the height finder. The cam is shaped to give a "lift" equal to the present horizontal range of the target.

While this is going on, the telescope which is following the horizontal travel of the target is moving a radius arm within the computer at a speed equal to the speed of the target. A pin on this radius arm is kept moving along a scale indicating the present horizontal range by an operator who "sets in" the range as obtained by the horizontal range cam.

The movement of the pin is thus an exact reproduction on a small scale of the course of the target, and is used to position two slides—one of which can move along an arbitrary North-South axis—and the other at right angles to it along an East-West axis. Through these slides the course of the target is broken down into its component velocities along the two reference axes.

To each of these slides is attached a "rate setting" mechanism such as described previously, which measures the speed of each slide by comparison with the speed of a constant speed motor. The first step in the prediction cycle is complete—the course of the target has been broken down into its two component velocities along right angle reference axes—and these component velocities have been measured in yards per second.

1st Ballistic Cycle: While this part of the prediction cycle has been going on, a series of eight ballistic cams have been rotated to the angular height of the future position of the target and their cam followers have been positioned by the future horizontal range.

The function of these cams is to act as "mechanical range tables"—to ascertain the *normal super-elevation* and *normal time of flight* for the angular height and horizontal range to which they are set, and to apply the necessary corrections for muzzle velocity and air density, and for wind. To perform these functions they are grouped as follows: *Normal super-elevation:* Head and follow wind, and muzzle velocity per cent air density; *Normal time of Flight:* Head and follow wind, and muzzle velocity per cent air density; *Cross Wind:* Drift.

The followers of the cams expressing corrections for wind direction and velocity are also adjusted according to data transmitted by the wind resolution mechanism which has been described. The follower of the muzzle velocity and air density cam has also been set from an adjusting knob on the computer.

If we trace the movement of one of the normal cams and its two correction cams, we can observe how their individual "lifts" are combined to give the corrected superelevation or time of flight for any position of the target.

The followers of the correction cams are on levers, from which any proportion of their lift can be taken off by a second set of adjustable levers. The combined lift of this second set of three levers is then taken off by an equilateral lever, similar in action to an equilateral triangle, with a lift at each corner and the resultant taken at the center of the triangle.

From this point the resultant is taken off and transmitted to a dial on the outside of the computer which indicates for

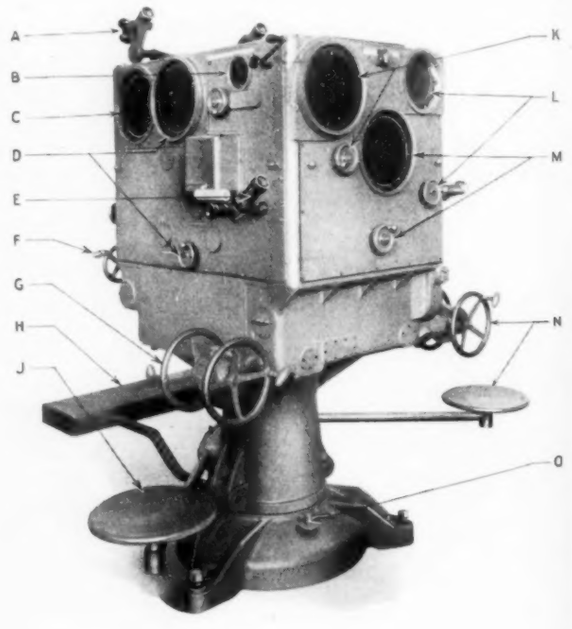

Fig. 3. Front View of Complete Computer.

A, Spotting 'scope; B, North and South rate dial and handwheel; C, Future horizontal range dial; D, Superelevation dial and handwheel; E, Azimuth tracking telescope; F, Future horizontal range handwheel; G, Traversing handwheel (azimuth tracking); H, Fire-control officer's platform; J, Azimuth tracking operator's seat; K, Time of flight dial and handwheel; L, Present altitude dial and handwheel; M, Present horizontal range dial and handwheel; N, Elevation tracking handwheel and operator's seat; O, Orienting clamp.

one set of cams:—*Corrected superelevation,* and for the other set, *Corrected time of flight.*

2nd Prediction Cycle: In the two cycles described above, the prediction mechanism has resolved the course of the target into two component speeds which have been measured—and the ballistic mechanism has computed, among other things, the corrected *present time of flight* to the target. The next step in accordance with the prediction principle already outlined, is to multiply these component rates by the present time of flight, and begin the flow of data which will eventually give the gun angles and fuze settings for the future position of the target.

The corrected *time of flight* is set back into the computer by a "manual servo-motor"—the operator merely matching dials on the time of flight indicator. The velocity of the North-South slide and the East-West slides, indicating the present position of the target, is already measured and expressed by the position of the ball carriages in the rate setting mechanisms for each slide.

The rate of each slide and the time of flight are *multiplied,* by the system of proportional levers already described, and the resulting movement expressing "distance" is transmitted to another system of North-South or East-West slides which are thus moved forward to a new position.

These slides—exactly similar to the slides indicating the present position of the target on the North-South or East-West axis—position a future radius arm which takes up a position reproducing the future position of the target. Since these two slides are indicating a future position of the target for a definite time of flight, their intersection, which positions the future radius arm also indicates the future horizontal range of the target (for the given time of flight), this future range being expressed in accordance with a scale of 2000 yards to the inch on the future radius arm. In accordance with the arrangement of an "altitude slide" and a "range slide" which has been described, these two slides position a lever which indicates the future angular height.

The position of the future radius arm also indicates the future azimuth of the target since its position is accurately reproducing the future position of the target.

In this prediction cycle we have obtained the future angular height of the target, and the future azimuth of the target, for a "set forward point" which at the moment has been determined by multiplying the component velocities of the target by the present time of flight and mechanically reproducing the movement of the target to indicate this "set forward" point.

Fig. 4. Elevation and Fuze-Setting Receivers on Gun.

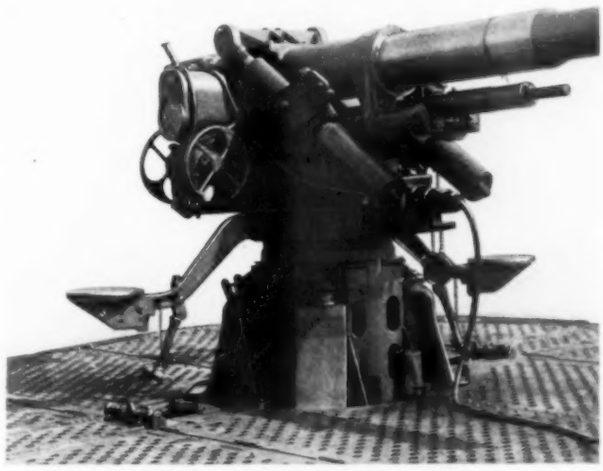

Fig. 5. Azimuth Receiver on Gun.

Data "Flow" Cycle: At this juncture we begin the "flow" of data which instantly responds to this initial prediction of a "set forward" point, based on present time of flight by a cumulative cycle of correction and recorrection which brings the predicted future position of the target up to the point indicated by the actual future time of flight.

The future angular height is set back into the computer by an operator "matching a pointer." This sets the ballistic cams to new positions, and new values of corrected time of flight and superelevation are indicated by the cams. The new time of flight changes the position of the future radius arm again, new angles of azimuth and angular height are predicted. These again are "fed back" into the computer and by the instantaneous and continuous action of this regenerative process of flowing together the new predictions and the new corrections, an accurate prediction is obtained of the actual future position of the target—the future radius arm and its subsidiary mechanisms indicating the future azimuth and the future angular height based on the future time of flight.

Final Correction Cycle: By the methods of mechanical addition already described, the future azimuth of the target is combined with the corrections for cross wind and drift—a correction for lateral spot is made at the discretion of the battery commander, and the resultant angle or angle of train is electrically transmitted to the guns.

The future angular height is combined with the corrected superelevation and allowances for altitude correction; vertical spot; and for possible diving of the target are added and the resultant angle, the quadrant elevation is transmitted to the guns.

The fuze range is obtained from another "mechanical firing table" cam, rotated in proportion to the time of flight. This fuze setting is corrected in accordance with the "dead time" required for setting the fuze at the gun and the va-

rious altitude and diving corrections mentioned above, and is then transmitted to the fuze setters on the guns.

It is well to emphasize at this point that, while the operation of the computer has been broken down into "cycles" for the purpose of making their relationships clear to the reader, the actual functioning of all of the mechanisms of the computer is practically instantaneous and the various steps in the solutions achieved are so coordinated and interlocked that in practice the computation, prediction and correction of the gun angles required are, in effect, but a single mechanical operation.

Fig. 6. The Sperry Antiaircraft Gun Control Unit in Action.

The outstanding characteristics of this mechanism,—the basic simplicity of the principles utilized; the provision for continuous and individual correction of all ballistic data; the actual prediction of the future position of the target by mechanical reproduction of its position in relation to fixed reference axis; the absence of mechanical strain on the mechanism itself; and the simplicity of the duties of the operators, who merely act as "servo-motors," are unique to the Sperry computer and are the basis for the remarkable accuracy and adaptability to the conditions of military service which it has achieved.

THE Sperry computer or data computer is an aluminum alloy housing mounted on a pedestal on which it can revolve. (Figs. 2 and 3.) The computer and its mount are usually carried on a mobile instrument trailer, which also transports the height finder and the transmission cables, and provides an operating platform from which the computer is manipulated when used in conjunction with a mobile antiaircraft battery. For fixed batteries the computer is emplaced on a suitable fixed foundation near the guns.

The officer supervising the operation of the computer, usually called the range officer, takes his station on a platform or footplate at the rear of the instrument. On his right hand at the front of the computer is the azimuth observer, who sits on a saddle and operates a set of handwheels which move the entire computer in azimuth, thus permitting him to follow the target with his azimuth-tracking telescope. On the left of the range officer at the front of the instrument is the elevation observer, who follows the target in the vertical plane by manipulating a similar set of handwheels controlling the elevation of both of the tracking telescopes.

The tracking adjustments of the two observers also control the movement of two sets of spotting binoculars, arranged for the use of the range officer and his assistant at the rear of the instrument. At the back of the instrument are also placed a series of dials and handwheels which permit these officers to adjust the setting of the computer or make spotting corrections in accordance with observation of test shots or observation of the target under fire. The setting for muzzle velocity—air density is made at this station, as well as adjustments for lateral spot and vertical spot, which permit the range officer to adjust the computer in anticipation of dives or other maneuvers on the part of the target. There are also dials and handwheels for indicating and adjusting the present altitude, future altitude, and fuze range. These are conveniently located.

Fig. 7. The Azimuth Receiver.

On the right side of the instrument, in addition to the azimuth telescope and azimuth training handwheels, are the "follow the pointer" dials and handwheels for the operators who act as manual servo-motors in setting-in future horizontal range and superelevation and in setting the "North-South" rate of movement of the target, the speed of which on this axis is indicated on a dial reading in miles per hour.

A similar manual servo-motor is used for setting-in time of flight, on the front of the instrument. The follow-the-pointer dials and handwheels for setting in present altitude and present horizontal range are also located on the front face of the computer.

On the left side are the rate-setting dials for "East-West" rate, for future angular height and for future azimuth. There are also the dials for setting in the wind azimuth and wind velocity and the dial indicating present angular height.

Electrical servo-motors are used for the various manual follow-ups, but dials and handwheels are provided for manual follow-up if the electrical gear is not used.

NINE operators, in addition to the range officer and his assistant or section chief, are normally used to handle the computer. These operators and their duties (Fig. 6) are as follows: (1) Elevation observer, tracks the target in the vertical plane; (2) Azimuth observer, tracks the target in azimuth; (3) Altitude setter, matches the pointer of dial indicating altitude as transmitted from height finder, setting present altitude into the computer; (4) Present range setter, matches the pointer setting present horizontal range back in computer; (5) East-West rate setter, matches the pointer on dial of rate mechanism; (6) North-South rate setter, same as above; (7) Future azimuth setter, matches the pointer—transmitting future azimuth to guns, corrected for cross wind and drift and lateral spot; (8) Future range setter, matches the pointer—sets future range into computer for ballistic and fuze cams; fuze cam combines future range and time of

flight and automatically transmits fuze setting to guns; (9) Future angular height setter, matches the pointer—setting future angular height back into computer, which is added to superelevation and vertical spot and transmitted to guns as quadrant elevation.

These operators also set up the computer in the field; connect the transmitting cables with the guns and the height finder; make the various preliminary adjustments of the instrument at the discretion of the range officer or battery commander and perform various other routine duties in connection with the operation or transportation of the instrument. It will be seen from the above outline that their duties are purely mechanical and that little skill or judgment is required on the part of the operators.

The height finder is a stereoscopic range finder which permits the observer to sense "depth" in a way which is not possible with the ordinary binocular or range finder. The height finder is trained by the azimuth and elevation trackers; the observer sets his adjustment so that the image of the target appears to him to be the same distance away as a series of reference points or "diamonds" in the field of vision; and when he has obtained the desired coincidence the "reader" transmits the result to the computer by matching the pointer or setting a pointer to indicate the reading on the instrument (depending on the type of height finder used).

The data transmitters indicating azimuth, quadrant elevation and fuze setting are an integral part of the computer and are connected to the power-plant on the trailer and to the guns through a central cable junction box on the trailer.

The elevation and fuze-setting receivers with their "follow the pointer" dials are shown mounted on the gun in Fig. 4. The azimuth receiver mounted on the gun is shown in Fig. 5. A close-up view of one of the dials of these receivers is shown in Fig. 7.

The mobile trailer on which the computer is mounted is designed to operate in conjunction with the other mobile elements of an antiaircraft battery, and is an underslung steel chassis, supported on low pressure balloon tires by semi-elliptic springs. As such it can travel at a normal road speed and offers a high degree of mobility and endurance over rough roads or as a cross-country vehicle.

In addition to the computer, which is usually operated from the trailer, operating platforms being provided for the men of the computer detail, the trailer also transports all the instruments, transmission cables, tools and spares used in the operation of the Sperry system.

To supply the alternating current needed for the electrical transmission there is a small motor-generator set, which receives direct current either from two 1¼ KW Delco gasoline generating sets, or from a 32 volt, 16 cell storage battery with a capacity of 160 ampere hours. Mounted at the rear of the trailer are four reels which carry the data transmission cables and on either side are smaller reels for carrying the cable for connection with the height finder, for telephone communication and for spare cable.

The height finder and other smaller instruments are carried in movable boxes strapped to the bed of the trailer. A standard equipment of tools is also carried in this way. Two spare wheels with tires are carried and a seat is provided at the rear of the trailer for a brakeman, who can control the movement of the vehicle through a set of internal expanding brakes on the rear wheel. Jacks are provided at each corner of the chassis for leveling the trailer platform in accordance with the indications of a set of liquid levels provided for this purpose. The jacks may also be used in changing tires or lifting the chassis over obstacles.

In service in the field it is possible for the operating crew to unload the height finder, connect up the transmission cables and generally prepare for action in the same time required for setting up the guns, usually about 20 minutes.

A Bombing Plane Launched by A Compressed Air Catapult at Farnborough, England.

Explosive Characteristics of Tetracene

Research Investigation at the Picatinny Arsenal Laboratories

By Wm. H. Rinkenbach* and O. E. Burton**

TETRACENE (guanyl-nitrosaminoguanyl -l-tetracene),

$$H_2N\text{-}C(=NH)\text{-}NH\text{-}NH\text{-}N{:}N\text{-}C(=NH)\text{-}NH\text{-}NH\text{-}NO$$

was first prepared by Hofmann and Roth[1], and its constitution and chemical properties were determined by Hofmann and his coworkers.[2] It was noted that the compound explodes when heated to 135°-140°C. or when subjected to impact.

Tetracene is used as a component in priming compositions, but the literature records very little information concerning its explosive properties. This paper gives the results of an investigation of its action as a detonating compound, but these are without reference to its value when used in priming compositions for small arms.

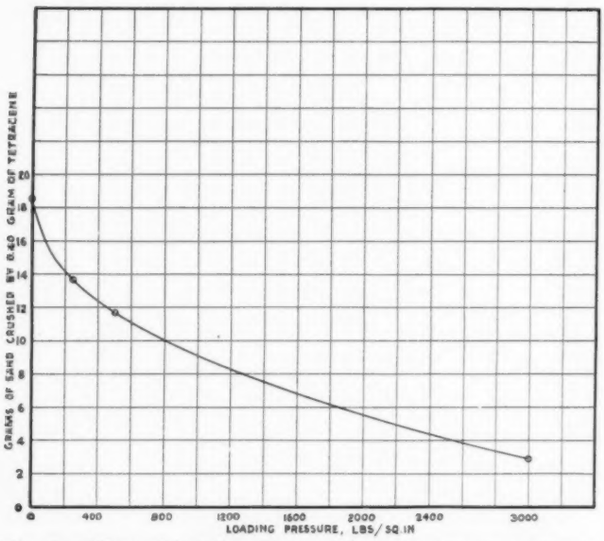

Fig. 1. Effect of Loading Pressure in Sand Test on Apparent Brisance of Tetracene Initiated with 0.10-gram of Lead Styphnate.

Preparation. Tetracene is prepared by dissolving 5 grams of aminoguanidine dinitrate in 30 cc. of water, cooling to 0°, and mixing with a solution of 2.5 grams of sodium nitrate in 15 cc. of water. The temperature is maintained at about 10°C., and 0.5-gm. of acetic acid is added. The tetracene separates out and is washed with water, alcohol and ether. It is then dried. Tetracene may also be prepared by placing aminoguanidine sulphate and sodium nitrite in a large beaker, and adding water heated to 30°C. The heat of reaction causes the mixture to boil; after standing for two or three hours the separated tetracene is filtered off, washed thoroughly and dried.

Properties. Tetracene is a yellow, fluffy solid of low density which is practically insoluble in water, alcohol, acetone, ether, benzene, carbon tetrachloride or ethylene dichloride. It is decomposed by boiling water; but is practically nonhygroscopic, as it absorbs moisture only to the extent of 0.77 per cent of its weight at 30°C. when exposed to a relative humidity of 90 per cent. Its apparent specific gravity is only 0.45; and when subjected to a pressure of 3000 lbs./sq. in. the resulting pellet has a specific gravity of 1.05.

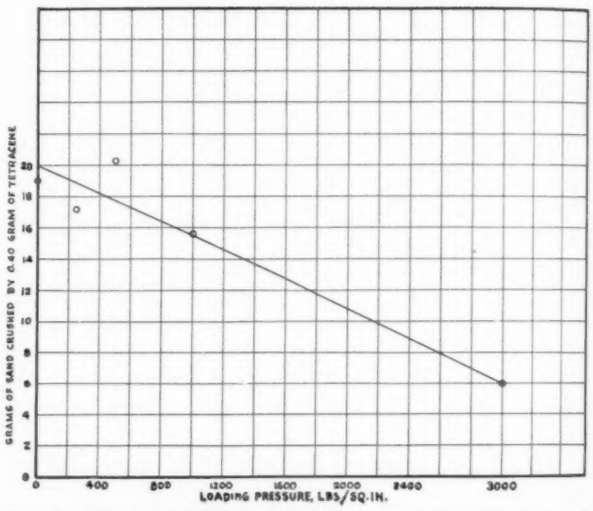

Fig. 2. Effect of Loading Pressure in Sand Test on Apparent Brisance of Tetracene Initiated with 0.20-gram of Lead Styphnate.

When brought into contact with a flame, tetracene explodes without appreciable noise, but with the liberation of much black smoke. Its explosion temperature was found to be 160°C., as compared with 190°C. for mercury fulminate. These values represent the temperatures necessary to cause explosion in exactly five seconds when a few milligrams of the explosive are placed in an empty detonator shell and this is dipped into a molten metal bath.

Tetracene is slightly more sensitive to impact than mercury fulminate, the fall of an 8-ounce weight through a distance of 8 inches being required to explode tetracene, whereas a fall of from 9 to 10 inches is required to explode fulminate.

When subjected to the International Heat Test at 75°C., tetracene lost 0.51 per cent by weight, but evolved no red fumes.

The apparent brisance (shattering effect) and initiating value of tetracene are dependent upon its density, which in turn is determined by the pressure to which it is subjected. In studying these variations, the standard sand test[3] was employed. Weighed charges in detonator shells were subjected to definite pressures and the weight of sand crushed in the bomb was determined. The results of these tests are given

*Chief Chemist, Picatinny Arsenal, Dover, N. J.
**Assistant Chemist, Picatinny Arsenal.

1. Berichte, 43, 682 (1910).
2. Hofmann, Hock, and Roth, Berichte 43, 1087 (1910). Hofmann, Hock and Kirmreuther, Annalen, 380, 130 (1911). Hofmann and Hock, Berichte 44, 2950 (1911).
3. Bur. of Mines Tech. Papers Nos. 125 and 145.

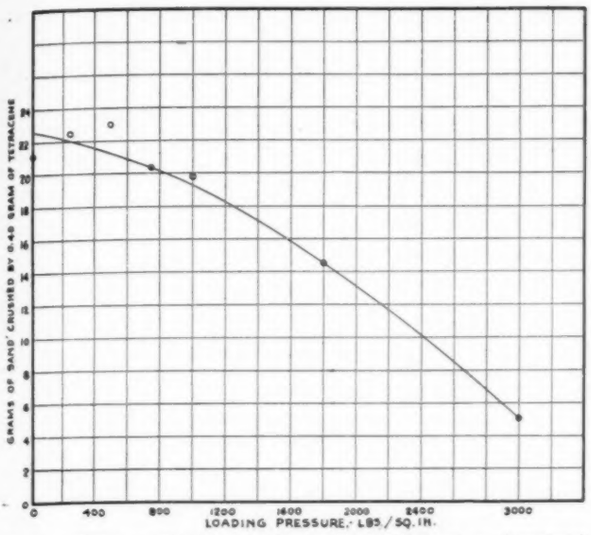

Fig. 3. Effect of Loading Pressure in Sand Test on Apparent Brisance of Tetracene Initiated with 0.40-gram of Lead Styphnate.

in Table I. A black powder fuze was used to cause explosion.

TABLE I

Gm. of Tetracene	Loading Pressure, Lbs./sq. in.	Gms. of Sand Crushed
0.40	0	13.1
0.40	250	9.2
0.40	500	7.5
0.40	3000	2.0

This variation might be due to the increase in compression decreasing the atmospheric oxygen in contact with the compound, or to decreased sensitivity to a flame and consequent "low order" explosions which give low brisance values. That the first possible cause is not the true one is shown by the fact that an oxygen-balanced mixture of tetracene and potassium chlorate shows similar variations in apparent brisance with changes in loading density (See Table V). It is, therefore, probable that the second is the true cause.

To determine whether the uncompressed tetracene had developed its maximum brisance when ignited with a fuze, charges with varying amounts of mercury fulminate as a primer were prepared and fired in the sand test. The results obtained are given in Table II and shown graphically on Fig. 7.

That the maximum brisance of tetracene is developed with 0.4-gram of fulminate as a primer was shown by using a compound primer of 0.15-gram of tetryl on the tetracene with 0.25-gram of mercury fulminate superimposed. The tetracene was found to crush 22.6 grams of sand.

From consideration of the curve shown on Fig. 7 it is apparent that:

(a) When more than 0.20-gram of fulminate is used as a primer, the brisance developed by the tetracene is dependent to some extent upon the quantity of initiator used; with 0.4-gram of the latter producing a maximum.

(b) When less than 0.20-gram of fulminate is used as a primer, the explosion of the tetracene is comparable with that of unprimed tetracene.

(c) 0.20-gram of fulminate may be considered the minimum charge necessary to produce approximately maximum brisance on the part of tetracene.

TABLE II

Tetracene		Mercury Fulminate		Total Gms. of Sand Crushed		Gms. Sand Crushed by Tetracene	
Gm.	Lbs./sq. in.	Gm.	Lbs./sq. in.				
0.40	3000	0.40	3000	39.8		21.1	
0.40	3000	0.30	3000	33.6		19.3	
0.40	3000	0.27	3000	31.4		18.4	
0.40	3000	0.25	3000	29.4		17.3	
0.40	3000	0.21	3000	27.0		16.4	
0.40	3000	0.19	3000	26.1	15.3	17.8	7.0
0.40	3000	0.18	3000	25.0	14.7	17.4	7.1
0.40	3000	0.17	3000	10.2		3.2	
0.40	3000	0.15	3000	7.3		2.0	
0.40	3000	0.00		2.0		2.0	

It would appear that the sensitivity of tetracene is such that a flame will cause a complete, but "low order," explosion and a more powerful initiating force is necessary to bring about a complete "high order" explosion.

Mercury fulminate is one of the most powerful detonating agents known, and it was thought that the use of a less effective detonating agent in place of mercury fulminate would

TABLE III

Tetracene		Lead Styphnate		Total Gms. of Sand Crushed		Gms. Sand Crushed by Tetracene	
Gm.	Lbs./sq. in.	Gm.	Lbs./sq. in.				
0.40	0	0.40	0	32.5		21.2	
0.40	250	0.40	250	33.8		22.5	
0.40	500	0.40	500	34.3		23.0	
0.40	750	0.40	750	31.7		20.4	
0.40	1000	0.40	1000	31.3		19.8	
0.40	1800	0.40	1800	25.8		14.5	
0.40	3000	0.40	3000	16.4		5.1	
0.40	0	0.20	0	23.8		19.0	
0.40	250	0.20	250	22.0	26.4	17.2	21.6
0.40	500	0.20	500	25.1		20.3	
0.40	1000	0.20	1000	20.4		15.6	
0.40	3000	0.20	3000	10.8		6.0	
0.40	0	0.10	0	19.9		18.4	
0.40	250	0.10	250	15.1		13.6	
0.40	500	0.10	500	13.2		11.7	
0.40	3000	0.10	3000	4.4		2.9	
0.40	500	0.25	500	26.5		20.1	
0.40	500	0.15	500	19.3		16.1	

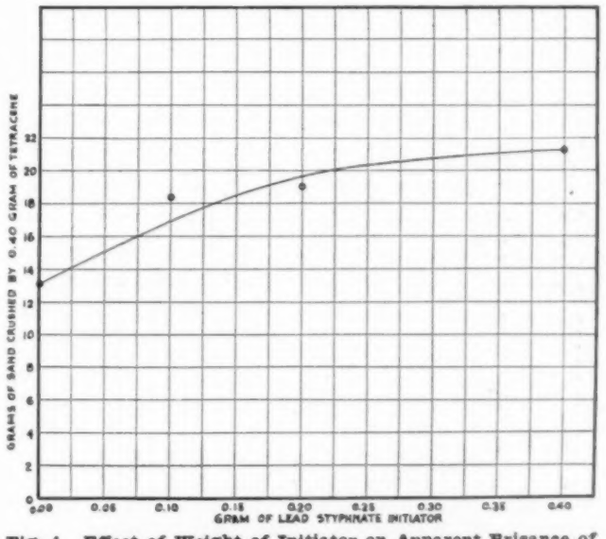

Fig. 4. Effect of Weight of Initiator on Apparent Brisance of Tetracene in Sand Test—Loading Pressure—0 Lbs./sq. in.

permit of more accurate conclusions as to the effects of variations in sensitivity of the tetracene as determined by its density, and of quantity of detonator. Lead styphnate (lead trinitroresorcinate) was chosen for this purpose; and the results of tests in which the loading pressure and the quantity of styphnate were the variables are given in Table III.

When the data given in Tables II and III are plotted as shown in Figs. 1 to 7, inclusive, it becomes evident that

(a) The sensitivity of tetracene, as reflected by the apparent brisance, is decreased when the charge is subjected to increased pressure.

(b) There is a direct relationship between the "order of detonation" of tetracene subjected to a given pressure and the amount of primer, when less than the charge of primer required to cause maximum detonation is used. In other words, the sensitivity of tetracene is such that the order of explosion is dependent upon the initiating impulse.

NO other compound having the wide range of variations in explosive effects shown by tetracene is known, and it is believed that the data given above throws new light on the mechanism of an explosion.

In general, explosive compounds have been divided into three classes:

(a) Progressive burning; in which the material undergoes a burning which increases to a maximum rate for any given set of conditions but which is relatively low under any conditions. Colloided nitrocellulose and black powder are typical of this class.

(b) Detonating compounds; in which the explosion caused by impact, friction, or flame almost instantaneously attains a maximum rate of propagation characteristic of the compound and ranging from 2000 to 5000 meters per second. Mercury fulminate and lead azide are representatives of this class.

(c) High explosives; in which flame causes no explosion with low confinement. A detonating agent must be used to initiate explosion, but is of the same nature as that undergone by the initiator—a high-velocity "detonation." TNT, tetryl and picric acid are typical high explosives.

It has been recognized that progressive burning explosives

TABLE IV

Tetryl		Tetracene		Lead Styphnate		Total Gms. of Sand Crushed	Gms. Sand Crushed by Tetryl
Gm.	Lbs./sq. in.	Gm.	Lbs./sq. in.	Gms.	Lbs./sq. in.		
0.40	3000	0.40	0			48.7	35.6
0.40	3000	0.40	500			7.9	F
0.40	3000	0.40	0	0.025	0	49.9	36.7
0.40	3000	0.40	250	0.025	250	13.7	F
0.40	3000	0.40	250	0.025	250	51.0	37.2
0.40	3000	0.30	0	0.05	0	29.3	F
0.40	3000	0.40	500	0.40	500	67.7	33.4
0.40	3000	0.40	500	0.30	500	63.4	33.6
0.40	3000	0.40	500	0.20	500	59.0	35.9
0.40	3000	0.40	500	0.18	500	62.8	41.1
0.40	3000	0.40	500	0.15	500	57.3	38.0
0.40	3000	0.40	500	0.10	500	54.2	39.2
0.40	3000	0.40	500	0.05	500	8.9	F
0.40	3000	0.20	500	0.25	500	13.6	F
0.40	3000	0.30	500	0.25	500	28.8	F
0.40	3000	0.40	3000	0.40	3000	24.4	F
				Mercury	Fulminate		
0.40	3000	0.40	3000	0.40	3000	75.0	35.2

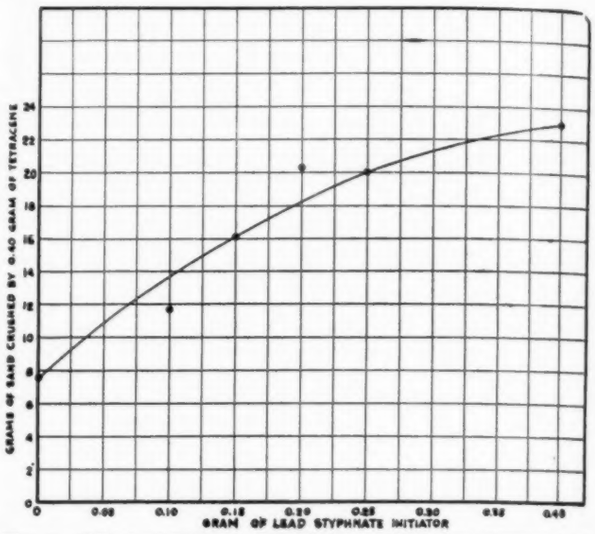

Fig. 5. Effect of Weight of Initiator on Apparent Brisance of Tetracene in Sand Test. Loading Pressure—500 Lbs./sq. in.

can be made to undergo detonation in certain cases by the use of a detonating compound as an initiator or by extreme confinement; and the available information has indicated that the chief difference noticeable between the two forms of explosion is the brisance rather than the explosive power. In general, the greater the density of the charge, the higher the rate of detonation. But little information is available concerning the relation between density and brisance, although the increase in rate of detonation would indicate an increase in sensitivity to an explosive wave with increase in density. A limitation in this tendency is to be found in mercury fulminate, which shows[6] a definite increase in rate of detonation with increase in apparent density from 1.8 to 3.0, but becomes "dead-pressed" when subjected to a pressure of 30,000 lbs./sq. in. When "dead-pressed," fulminate burns, but does not detonate, when brought in contact with a flame; but this merely represents desensitization, as "dead-pressed" fulminate detonates with normal brisance and initiating power when primed with a small amount of fulminate which has not been subjected to high pressure.

Tetracene, therefore, appears to be insensitive to such an extent that a flame cannot cause detonation at the maximum rate, and it undergoes a much more gradual "dead-pressing" at pressures much lower than those required to produce the same phenomenon in mercury fulminate. In view of the fact that the apparent brisance value of tetracene, in grams of sand crushed by 0.4-gm., can be made to vary from 2.0 to a maximum of 22, dependent upon the density and method of initiation, it is indicated that with this compound it is possible to develop rates of explosion which vary in small intervals from those typical of "progressive burning" to those considered to be "high order detonations."

The basis of this is conceived as being the impact (pressure) derivative of the time, temperature and chemical equilibrium variables involved in the explosion of this compound. The general correspondence between the rate of detonation and brisance effect implied is largely due to the time factor common to both. With increased duration because of lower sensitivity, the rate of acceleration of explosion will be correspondingly reduced, probably resulting in a

6. L. R. Carl, ARMY ORDNANCE, 6, 303 (1926).

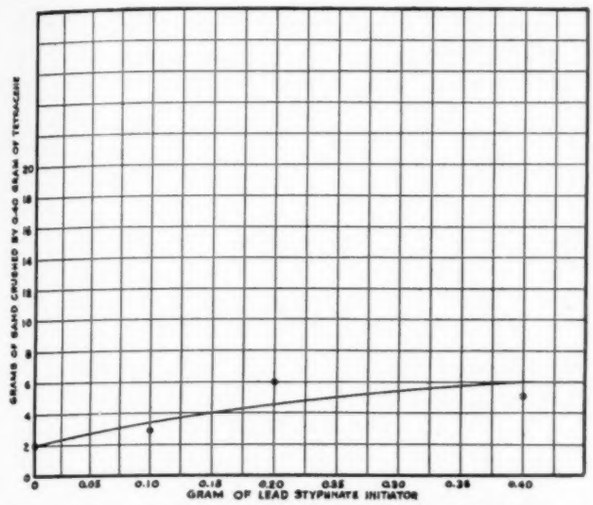

Fig. 6. Effect of Weight of Initiator on Apparent Brisance of Tetracene in Sand Test. Loading Pressure—3000 Lbs./sq. in.

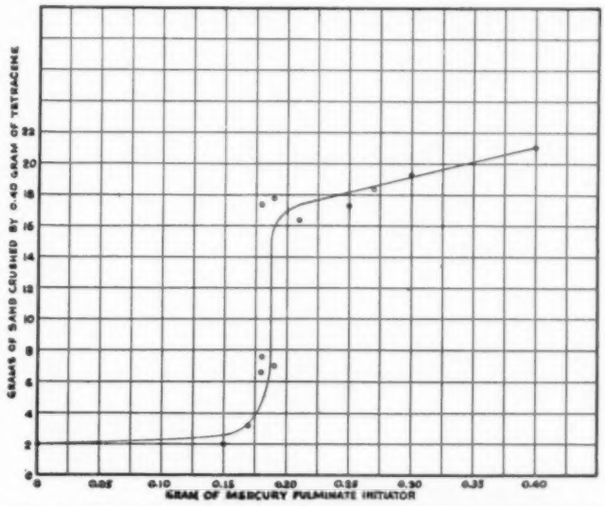

Fig. 7. Effect of Weight of Initiator on Apparent Brisance of Tetracene in Sand Test. Loading Pressure—3000 Lbs./sq. in.

lower maximum temperature and/or a less exothermic chemical equilibrium of the products of explosion.

Inasmuch as the initiating efficiency of a detonating explosive is also proportional to its brisance, it would be expected that the wide range of apparent brisance-effects of tetracene would be reflected in its action as an initiating compound. The data given in Table V shows this to be true, in that a wide range of detonating-effects is found to be obtainable when the density and initiation conditions are varied in the same ways found to give a wide range of brisance-effects.

FROM inspection of the data presented in Table IV it is apparent that the following minimum priming charges of lead styphnate are necessary to enable 0.40-gram of tetracene to bring about the detonation of tetryl:

0.4 Gram of Tetracene Pressed Lbs./sq. in.	Minimum Charge of Styphnate Primer	Gms. of Sand Crushed by Tetracene (Tables I and III)
0	0	13.1
250	0.05 gm.	13.5
500	0.10 gm.	11.7
3000	0.40 gm.	5.1

These values make it evident that there is a direct relationship between the brisance developed during an explosion and the initiating value of the compound during that explosion. It is of interest to note that the brisance values (11.7 to 13.6 grams of sand) of 0.4-gm. of tetracene at different densities representing minimum detonating charges for tetryl are in close agreement with that of 12.1 grams of sand given by 0.23-gm. of mercury fulminate, the minimum detonating charge for tetryl.

This cannot be interpreted too literally, however, as 0.28-gm. of mercury fulminate, which crushes 13.5 grams of sand, will detonate TNT (trinitrotoluene), but 0.4 gram of tetracene pressed at 500 lbs./sq. in. and initiated with 0.4-gram of lead styphnate will not do this although the tetracene develops its maximum brisance (23 grams of sand, See Table III) under these conditions.

Tetracene is deficient with respect to oxygen content, and a mixture with potassium chlorate was considered to offer possibilities in the direction of increased brisance and initiating value and decreased sensitivity range. Sand test values for the theoretical mixture (39.7 per cent of tetracene) and two others are given in Table V.

TABLE V

Composition of Mixture		Gm. of Mixture	Loaded, Lbs./sq. in.	Initiated by Gm. Mercury Fulminate	Total Gms. Sand Crushed	Sand Crushed by Tetracene Mixture
Per Cent Tetracene	Per Cent $KClO_3$					
39.7	60.3	0.40	0	Flame	15.0	15.0
		0.40	3000	Flame	8.8	8.8
		0.40	3000	0.20	36.3	26.5
50.0	50.0	0.40	3000	0.20	40.7	30.9
75.0	25.0	0.40	3000	0.22	34.1	23.3

The 50-50 mixture being preferable, although a wide range of sensitivity is apparent, the initiating value of this was determined as shown in Table VI.

TABLE VI

Tetryl		Tetracene-Chlorate Mixture		Lead Styphnate		Mercury Fulminate		Total Gms. of Sand Crushed	Gms. Sand Crushed by Tetryl
Gm.	Lbs./sq. in.	Gm.	Lbs./sq. in.	Gm.	Lbs./sq. in.	Gm.	Lbs./sq. in.		
0.40	3000	0.40	0			Flame		18.2	F
0.40	3000	0.40	0	0.40	0			77.4	37.2
0.40	3000	0.40	250	0.40	250			78.1	37.9
0.40	3000	0.40	1000	0.40	1000			59.7	F
0.40	3000	0.40	3000	0.40	3000			24.3	F
0.40	3000	0.40	3000			0.20	3000	76.2	35.5
0.40	3000	0.20	3000			0.20	3000	56.7	31.5

The data do not indicate the tetracene mixture to be markedly superior to tetracene with respect to initiating value, although it possesses a marked superiority with respect to maximum brisance developed.

Summary. 1. Tetracene has been shown to possess an extremely wide range of sensitivity to explosion. It appears to become desensitized by increasing pressures so gradually that explosion rates varying from progressive burning to "high order" maximum detonation can be developed.

2. The brisance-effects of tetracene vary with its sensitivity to initiation, and the initiating value of the compound is, in general, a function of the brisance.

3. Neither tetracene nor its mixture with an equal weight of potassium chlorate is as satisfactory an initiating agent as mercury fulminate.

The Martin Dam Development on the Tallapoosa River, Ala.

The Industrial Role of the South

Munitions Possibilities of the Birmingham Ordnance District

By D. N. Hauseman*

FOR many of us, thoughts of the South often picture scenes of romance associated with antebellum plantations, sunshine and playtime. Romance still exists in the South, yet underneath it is a thrilling story of material achievement from the time the first golf club in the United States was organized in Savannah and the first steamship to cross the Atlantic was owned by Southern men and sailed from Savannah—to the present day.

Accurate information regarding the South is not widespread among people of other parts of the country. How meager this information is illustrated by a story of an Eastern college class in economics studying industrial survey problems. One of the exercises given the class was to explain why a large corporation would locate a cast-iron pipe plant way down in Gadsden, Alabama. The answer as given by the professor was that the town was adjacent to coal and iron mines, it had cheap negro labor, available river transportation, it was a rail center and had natural gas for auxiliary fuel. Actually Gadsden is relatively distant from coal and iron mines, pipe foundry labor is largely white, it is not located on a navigable river, one main line and one branch railroad operate through the city and the nearest source of natural gas is 400 miles away and has just recently been piped to the city.

The Southerner is often on the defensive and is obliged to explain the great industrial development and the present day giant strides of the South. Many unfamiliar with the present South are still thinking of it in terms of Southern gentlemen and negroes, fried chicken and grits. Let us see why this romantic struggling, gasping, almost prostrate section of seventy years ago has risen and come into its own.

Sound the call, "Minerals." About sixty will respond. Nearly all the great mineral resources possessed in the United States or a duplicate will be found advantageously located within its borders. The *Blue Book of Southern Progress* states that the South has a greater combination of raw materials for industrial pursuit than any other equal area in the world. There is not any other location where within a radius of five miles are found coal, iron ore and limestone necessary to make pig iron and steel. It is interesting to note that with approximately 100,000 square miles of coal land, the South has more than twice the coal area of Europe. The coal and iron ore could be mined at the present rate for 500 years without evidence of diminishing returns. Practically all the large steel companies have blast furnaces and rolling mills in the district and evidence points to the fact that within a few years additional capacity will be installed in this major industrial development. Over $18,000,000 was spent in the Birmingham Ordnance District alone on extension of steel plants in 1930. In the $100,000,000 class is Alabama's cast iron pipe industry. Its iron pipe is known throughout the world and is shipped to many foreign lands.

PARALLEL with the iron and coal development has been the coke and by-product industry. Besides furnishing gas for industrial and domestic uses, thousands of gallons of light oil are distilled daily for its benzol, toluol, xylol, ammonium sulphate and coal tar and other important by-products.

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Petroleum is another great and rich Southern resource. Little need be said of the scope of this operation except to call attention to one of its large industrial investors—The Standard Oil Company of New Jersey. Their Southern operations are tremendous, having an intricate network of lines gathering and routing its crude oil to its refineries in Baton Rouge and Baytown. The Baton Rouge refinery covers over

Plant of the Swann Chemical Company, Anniston, Ala.

2,000 acres and employes 5,500 men. It has 1,567 miles of trunk pipe lines, handling 43,000,000 barrels of oil annually. An $8,000,000 hydrogeneration plant is under construction on this property.

In keeping with this vast store of coal, iron ore and oil is natural gas. The past year has seen the extension of many miles of gas lines from Louisiana throughout the South and even to the Northwest. Nature's latest gift to the State of Mississippi is what appears to be an unlimited quantity of natural gas. A large field has been located in the corporate limits of the city of Jackson.

Its phosphate rock for fertilizer and acid, its sulphur, bauxite, graphite, its limestone are found in almost limitless quantities and have been utilized for years. Clays, including kaolin, are the bases for large industries and are equal to the world's need for centuries. Marbles of many kinds, granites of the highest quality have been extensively developed and are found in various parts of the South. Manganese deposits were opened up several years ago and offer possibilities for future expansion for this important mineral so essential in the manufacture of high grade steels.

Heretofore the Southern farmer found it necessary to concentrate on cotton and tobacco mainly because of the lack of marketing facilities. There was no diversification of farming products because of the lack of home markets. Today Southern business men are taking hold of the situation vigorously and are establishing the much needed marketing facilities. As a result, foodstuffs of all varieties are now on our list of products farmed.

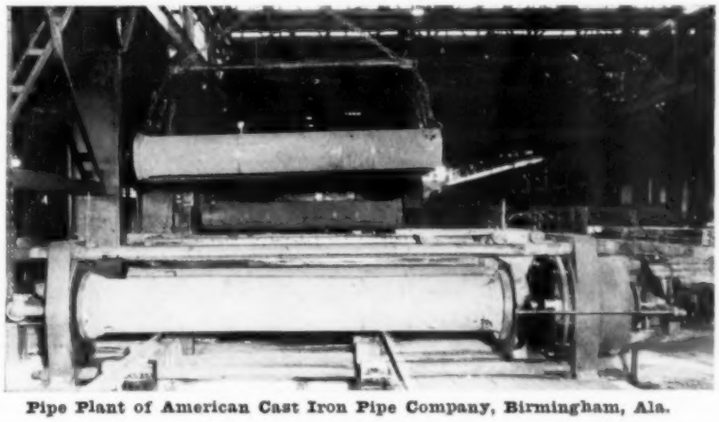
The subject of trees as an agricultural crop is receiving special attention and more than ever the lumber industry is getting on a self-perpetuating basis. Big capacity mills have been established with a supply of logs assured through the growing of timber on an intensive scale and through selected cutting and utilization of scientific reforesting methods.

The South's furniture industry has made rapid development. According to the *Manufacturers' Record* (from which many of the facts and figures used in this article are taken), the Southern states now make one-fourth of all the wooden furniture produced in the United States. It is also diversifying its woodworking industry by the manufacture of many special products. The paper industry which consumes large quantities of mill waste and second-growth timber and the refuse of lumbering operations is concentrating in the South. A further step covers the establishment of plants for production of building and insulating boards.

Now the South is beginning to can the output of farms and groves. The outstanding development of last year was the establishment of plants for the canning and distribution of citrus fruit. Luscious fresh Georgia peaches are now available for breakfast throughout the country the year round. A peach freezing plant was built some months ago at Montezuma, Georgia. A combination of the ammonia and carbon dioxide system is used to produce the low temperature required for instant freezing. The distribution of the frozen product to the trade is effected by the use of "dry ice."

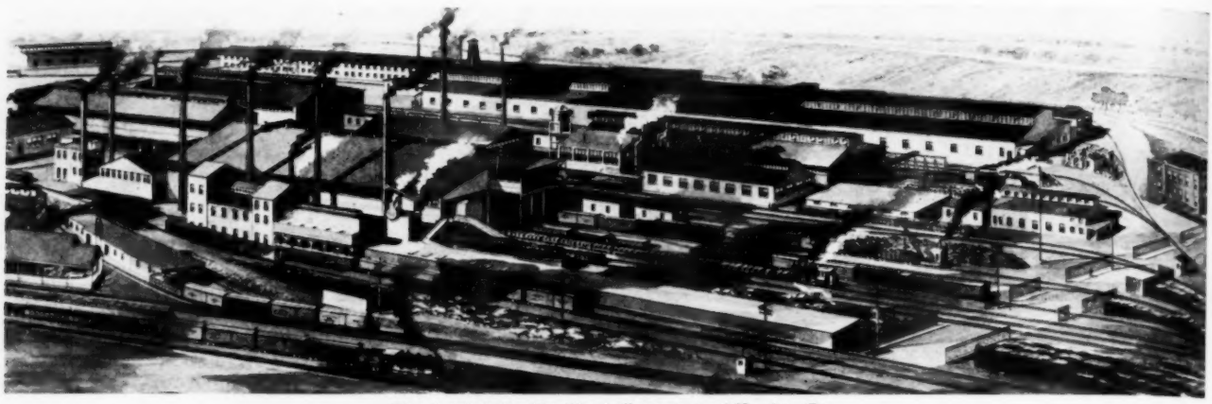
Many think of the South as a great agricultural region—where are produced more and greater variety of crops than any part of the United States—however, the value of the South's industrial products each year is almost twice the value of its agricultural products.

OF course the word "South" is always associated with cotton fields but few realize that the South now consumes more than 70 per cent of all the cotton used in American



Pipe Plant of American Cast Iron Pipe Company, Birmingham, Ala.

mills. In 1921 the nation's attention was centered on the concentration in the South of the textile industry, made conspicuous by the movement of mills into this section from the North and East. A little later the rayon industry began to center in this section so that today there are a number of huge mills making rayon from cotton linters and wood pulp.



Plant of Atlantic Steel Company, Atlanta, Ga.

With the location of so many important rayon, textile and paper manufacturing plants, development of a diversified chemical industry is being fostered. The plants are located in all parts of the territory near sources of raw material, cheap fuel and abundant power. Such products as ammonia, sulphuric acid, methanol, alcohol, cellulose, acetate and cotton-seed oil are manufactured. Cotton seed-oil is refined into its many byproducts such as salad oil, cosmetics, soap, glycerine, insulating materials and paints.

The phosphoric acid industry as well as that of fertilizers and lime is largely located within the South. Far different from 25 years ago when the list was very small, today Southern chemical industries and their products are large and varied.

Another of the agricultural raw materials for the chemical industry—naval stores—is one of the oldest on the continent. Chipping the pine trees for the valuable gum was started by the early settlers. Production of resin, pine oil and turpentine always has been, and still is, a Southern industry.

Industrial progress is being tremendously stimulated by the electric power generated. A network of wires is being stretched over the entire South furnishing power for every variety of industry. They are interconnected and form one vast superpower system. Although the South is primarily a hydroelectric section, a secondary battery of steam plants has been installed for supplementary power and to meet emergencies. Of the 12,141,846 h. p. developed in the United States on June 1, 1930, by public utility plants, the South contributed 3,756,505, or 31 per cent.

A large proportion of the southern industries are inland and are strategically located. If ever our present vulnerable eastern and manufacturing areas are attacked by an enemy—many will be obliged to seek our available inland industrial sites. Many new industries have located here in the last ten years and if this country is fortunate enough to be free from invaders a few more years, many more industries will have moved to this land of romance.

Surprising though true, the South was the industrial leader of the nation up to 1810 and not at all backward for the next 50 years. The Civil War was disastrous to Southern industry, under the impetus of war necessity and because of the blockade of Southern ports the iron and textile industries were greatly expanded. But with penetration of the Union armies, factories and mills were crippled everywhere with the result that Southern manufacture and agriculture were retarded and handicapped and in many cases prostrate.

Struggling for years, gasping for breath for several decades, this prostrate section had a hard time to rise and come into its own. The large business operations had to depend on outside capital. However, year after year Southern capital has been increasing and with this a renewed and reawakened energy and a development of which it is proud and which is of far-reaching importance.

By no means is this brief survey of the South complete. It merely gives a few outstanding facts. There are many other contributions. Enough has been said, however, to show why we believe in the South and why we are justly proud. Enough has been said to show that we are in the midst of an important economic evolution.

In no desire or effort to underrate or belittle the progress made in other sections of the country, it is merely desired that all realize the future possibilities of the South.

Why this article on "The Industrial Role of the South" for ARMY ORDNANCE? Just this—in so far as industrial activity was concerned during the World War—we are not particularly proud of our record. We were only given a few large industrial tasks. These were accomplished on time and satisfactorily but many did not secure the opportunity to prove their worth. At times it seems we were just ignored. It was believed that the South was the industrial "weak sister." The concerns that did war work did so on subcontract from companies in other localities. Few had prime contracts from the War Department.

Today as far as industrial preparedness is concerned, the South because of its present development is possibly only of secondary importance. But because of its great resources combined with its strategic location the South is potentially one of the most important areas in the scheme of industrial preparedness.

The ordnance responsibilities in the portion of this area embraced in the Birmingham Ordnance District are under the guidance of Col. John Stephen Sewell, District Chief, and Col. Theodore Swann, Assistant Chief. They are capably assisted by the following advisory board: Erskine Ramsey, Lester F. Alexander, Frank H. Crockard, Thomas Elliott, Robert Gregg, Thomas W. Martin, E. E. Norris, Brig. Gen. Robert J. Travis, Oscar Wells, W. D. Tynes and Lieut. Col. W. B. Hamilton.

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Month by Month

PLANS for the sessions of the Thirteenth Annual Meeting of the Army Ordnance Association are progressing apace. The preliminary announcements which appear elsewhere in this issue and the detailed literature which has been sent to all members of the Association will indicate, we believe, that the meeting this year will be one of exceptional interest.

Our October Meeting

The business and technical session which will be held in the Council Chamber of the United States Chamber of Commerce at Washington on the evening of Wednesday, October 7th, will be devoted to discussions by authorities on munitions preparedness subjects. This session, now in its second year, bids fair to become an annual event of outstanding importance. On this occasion the gold medal for meritorious ordnance service will be founded by the Association and its first awards will be made.

The program of test firings and demonstrations which will constitute the technical and scientific session of our meeting at the Aberdeen Proving Ground on the following day, Thursday, October 8th, is being arranged, with the approval of the Secretary of War, with its prime purpose in view. That purpose, it will be remembered, is to acquaint our members with latest developments of munitions design. The past twelve years have proved the value of such an annual stock-taking and it is hoped that the coming meeting will be a worthy indication of its continued importance.

Participating in the sessions will be the National Industrial Conference Board and the United States Naval Institute. Both are organizations doing splendid work in their respective fields with whom the opportunity of this contact has many mutual advantages. There is every expectation that the Thirteenth Annual Meeting will represent an even more important stage of munitions development than have its predecessors, and it is hoped that there will be a large attendance of members at both sessions.

NO finer thing for the advancement of interest in small-bore rifle shooting could have happened than the victory scored by the British over the American International Team at Bisley, England, July 6-11, 1931. The English team won by a two-point margin 3927 to 3925. Some commentators in reflecting upon the American loss have referred to the adverse conditions under which the American team competed. They point out the firing under a strain after an ocean voyage and only five days of practice on an unfamiliar range. These conditions, while they may have been bothersome even to the superb team representing the United States, are not to be advanced as excuses. The fact is that both teams were admirably matched and the closeness of the score indicates that a real battle was fought. Those who have at heart the interests of small-bore shooting the world over will rejoice at the outcome. It means an impetus to the spirit of friendly rivalry which can do only a tremendous amount of good for small-bore shooting in both countries.

A Deserved Victory

For those who must have consolation, the victory of Maj. Julian S. Hatcher, Ord. Dept., U. S. A., Captain of the American International Team, who captured first honors in the Webley and Scott Pistol Competition by shooting a perfect score of 100, there is satisfaction aplenty. When all is said and done sustained interest in rifle and pistol shooting depends upon competition and as we see it there can be gain even in our loss to the splendid shots of the British Team. Congratulations to the winners and losers alike and wishes to both for further success! For the British it was a well-deserved and highly gratifying victory; for the Americans, an impetus to even greater interest and effort.

THE opponents of reasonable preparedness are attacking on a wide front. Professor Albert Einstein, whose excursions into this field are remembered in connection with his visit to this country last year, goes previous attacks one better in his appeal to the scientists of the world to refuse to coöperate in research for the creation of new instruments of war. His message, as cabled to the *New York Times,* was read to the International Conference of the Opponents of War in session at Lyons, France. He is reported to have appealed "to all men and women to declare, before the Disarmament Conference meets in Geneva in February, that they will refuse to give further assistance to war or to war preparations." He concludes by saying that "we face today a militarism far more powerful and destructive than that which brought on the World War disaster."

National Defense and Research

Professor Einstein and others who share his views in this respect are forgetful of the great advantages to modern life which had their beginnings in "research for the creation of new instruments of war." Possibly one who is so deeply engrossed in the workings of the cosmos has forgotten that the majority of elemental scientific progress of modern days had some connection with national defense. In the field of metallurgical advancement alone this is as true of his own country as it is of ours. One need only cite what the World War did for aviation to prove the point. It would be a difficult thing indeed for the serious-minded listeners to the professor's appeal to limit themselves to any such program. While the evolution of new instruments of war undoubtedly bestowed benefits upon peace-time progress, the opposite is

equally true, so that in time of emergency the advancements of peace are equally applicable to the needs of war. Whether or not Dr. Einstein's attack is based on reasonable grounds when directed at others, it is certain that it has no bearing in this country. Here we place full reliance upon research and experiment leaving to an actual emergency the problem of turning the quantitative results to the purpose of national defense.

Industrial Preparedness in Public Affairs

THE management of the Institute of Public Affairs of the University of Virginia, in compiling the program for the summer season of 1931, included a round-table discussion on industrial preparedness. This was a portion of a general round table on the new industrialism of the South under the leadership of Maj. LeRoy Hodges, Managing Director of the Virginia State Chamber of Commerce, State Ordnance Officer of the Virginia National Guard, and an active member of the Army Ordnance Association.

The program was featured by addresses by the Assistant Secretary of War, Hon. Frederick H. Payne; Brig. Gen. Benedict Crowell, President of the Army Ordnance Association; and Col. Charles G. Mettler of the Ordnance Department. The papers collectively embody an accurate restatement of our industrial preparedness philosophy. With the permission of Dr. Chas. G. Maphis, Dean of the Institute, they will be published in the next issue of this Journal.

The point worthy of emphasis here is that an institution which has assumed first rank as a forum for the discussion of questions of national importance is cognizant of the vital meaning of industrial preparedness. It is somewhat of a departure from procedure of a generation ago to think of national defense in terms other than standing armies and huge supplies of war equipment and yet the whole trend being on a very logical footing is away from militarism and toward preparedness through peace-time planning. It is a very encouraging sign when so influential a body as the Institute of Public Affairs devotes a period of its study to this very important subject. We hope that some phase of it will always be included in the agenda and that other institutes even of less renown and scope will do likewise.

The Curtain Falls on Brandywine

THE announcement of the duPont Company that its experimental smokeless powder laboratory formerly located at Henry Clay, near Wilmington, Delaware, and known so long as the Brandywine Laboratory, has been removed to Carney's Point, New Jersey, will cause a feeling of regret at the passing of an historic landmark closely identified with the nation's progress. Although the change is made for reasons of convenience and efficiency and notwithstanding the new facilities embraced in the ballistic and chemical laboratories and the semiworks plant erected at Carney's Point and aside from the splendid tribute in naming the new establishment in honor of Charles F. Burnside, a pioneer smokeless powder maker of America—all of which are most certainly commendable, still the fall of the curtain on Brandywine recalls so vividly the courage of days gone-by that one must pause in tribute.

Here it was, on ground already made sacred in the Revolution, that Eleuthère Irénée duPont de Nemours, founder of the great organization which bears his name, came in 1802 to establish his first powder mill. Thomas Jefferson had wanted it built in Virginia or Maryland close to the Nation's Capital but duPont finally located at Brandywine and in 1804 began operation of the "Eleutherian Mills." Sales for the first year (1804) were only 11,000 pounds. An order for twice that quantity was soon placed for use on the American frigates which were sent to Algeria against the Barbary pirates. In 1811 when war with Great Britain threatened, larger orders were received and in 1834, when E. I. duPont died, there was no doubt of the success of the venture at Brandywine which he had established and struggled to build up through thirty-two years of hard work.

Thence through the Crimean, the Mexican and the American Civil wars, Brandywine contributed its products to the settlement of disputes, to the development of the West and the industrialization of the North and East. Here were carried on the experiments with Captain Rodman, of Ordnance fame, on his large-grained, perforated cake powder. As expansion came and other plants were erected, Brandywine and its forty-seven water wheels and later its steam engines carried on. In 1891, the Carney's Point gun-cotton plant was erected coincident with the beginning of smokeless powder development in the United States. Brandywine, hallowed with traditions, then became one of the country's foremost experiment stations. From the simplest beginnings it grew to an institution of first rank.

The march of progress thus records the passing of Brandywine which, like the good qualities of the two names it combines, gave sustenance and vigor to a newcomer in the family of nations and improved with age in mellow and fruitful achievement. May the historian turn from Brandywine to Burnside and read an unbroken narrative of service and may the vision and perseverance of the founder rise from venerable Brandywine to guide and prosper its successor.

Achievements Toward Higher Velocities

THE latest advancements in obtaining increased muzzle velocities described by Dr. Gerlich elsewhere in this issue have been the cause of considerable speculation both in the scientific and daily press here and abroad. Unfortunately much of the information which has appeared in the daily press has been badly garbled, the spectacular as usual taking precedence over fact.

While for obvious reasons the inventor is not able at this time to describe in detail the methods by which his results are obtained, it will be, we hope, our good fortune to publish in these pages a paper by Dr. Gerlich giving detailed procedure as soon as conditions are appropriate. It is interesting, however, to learn from the author that the weight of the bullet used in the latest official tests was 6.5 grams, or about 100 grains. With this bullet a velocity of 5300 f. s. was reached while with the same bullet but with another propellant and load a velocity of 5800 f. s. was obtained.

The possibilities of increased velocities and their effects upon the design of both small arms and larger ordnance indicate that the investigations of Dr. Gerlich may have a very pronounced effect upon the whole trend of armament.

The U. S. Peace Department

An Editorial

WE had occasion in this place in the July-August issue to refer to Mr. Kirby Page, editor of *The World Tomorrow,* in connection with the letter which he addressed to some 19,000 clergymen to ascertain their attitude on bearing arms in time of war. In that reference we joined with General Douglas MacArthur, Chief of Staff of the United States Army, in expressing surprise at the results disclosed by such an unusual letter. Since then Mr. Page has come forward with an elaborate program of peace by propaganda—a commendable thought, as novel as it is idealistic.

In an address at the Institute of Public Affairs at the University of Virginia (several days prior to the presentation of papers on industrial preparedness before the same body by authorities on the subject), Mr. Page outlined his program for world peace and the organization for effecting it to be established in the United States. "An adequate peace program," he said, "demands a Department of Peace in our Federal Government, as well staffed and equipped as the other departments with a Secretary of Peace as a member of the President's Cabinet and a national peace budget of approximately $100,000,000." This budget, he explained, would provide for regional offices in the United States, each with ten regional secretaries; twenty research specialists, forty foreign offices, each with five foreign secretaries; an editor-in-chief of peace publications and an adequate staff; the free circulation of 1,000,000 copies of a monthly "peace magazine"; the free circulation of 12,000,000 copies of peace booklets annually; daily radio programs over nation-wide networks; the production of twenty peace moving-picture films each year; the support of 5,0000 American students abroad and the same number of foreign students in our colleges and universities; the maintenance of an international university; world friendship cruises annually; the erection of peace monuments and the support of numerous international projects. Insisting that the "war system" must be torn down and that the United States must assume a position of "vigorous leadership" in the world disarmament conference at Geneva next February, the speaker urged that there be substantial reductions in war equipment and expenditure and that individual citizens "withdraw their support" from the "war system."

THE idea of a U. S. Peace Department is not new, indeed it dates back to 1789 when President Washington appointed Henry Knox the first Secretary of War in charge of the War Department. The Page proposal (which is sponsored by such organizations as the First Humanist Society) must therefore be more than one of name because what we call our war agency is essentially for the preservation of peace. No one can contend that the War Department "makes war"; its job is to make peace after the people have decided to make war. The argument, if there can be an argument, hinges on the efficacy of a peace department organized and operated on the Page pattern versus a war department as now constituted. That is to ask shall we have peace by pamphlets or peace by preparedness? We believe that no amount of so-called education, whether it be through movies, booklets, foreign and domestic secretaries, editors-in-chief and exchange scholarships will quite enforce the will to peace as quickly and as efficiently as a system of defense "with teeth in it." If facts mean anything, the world was pretty well educated thirteen years ago! So we venture to suggest that Mr. Page could distribute his millions of pamphlets till doomsday and they would not deter the rabble bent on plunder nearly as effectively as one one-millionth of the same number of rifles. Such propagandists should know that we have in fact a Peace Department. It has restored peace and sustained it for a century and a half. Its job done until the next frenzied outburst it has always turned to the things of peace in every field of endeavor—in character building, in physical development, in exploration, in engineering and scientific progress—in a word to Americanism.

IF, as a people, we are to be what we are, if our institutions are to be perpetuated along the same paths which saw their inception and fulfillment, our present Peace Department with its doughboys rather than speaker's bureaus, its officers rather than secretaries, its battle strategy and tactics rather than moving and talking pictures, and its weapons rather than pamphlets, will perform its mission as it has in the past. It will rely on discipline and the workshop for men and munitions and it will stand four square for the right even after the pamphleteer has seen his printed propaganda in ashes and naught else to protect him. Americans, we believe, will stick to their guns under whatever name they be marshalled and take their movies and booklets and all the rest for the little defense value they are worth. In reality ours is not a war system manipulated by a War Department; it is a peace system administered by a Peace Department. It differs from the Page proposal in that it admits the possibility of an aggressor of whom there have been many—individuals and peoples—since the beginning of time. And it further acknowledges as a matter of fact that a sanction, whether it be handcuffs and prison bars for individuals, or dreadnaughts, airplanes, guns and explosives for peoples, is sometimes a necessity when words can only make known the right but action is necessary to sustain it.

Aside from the futility of the entire proposal we rise on behalf of the ladies and gentlemen of the radio audience to ask what is to become of our enjoyment of favorite radio programs if the proposed Peace Department has huge public funds at its disposal for daily air programs with which to denounce the "war-system" and to describe the work of the peace secretariats abroad? That alone is a "propolition" which could easily lead to a "picklement" in the form of domestic insurrection and even civil war and no amount of pamphlets could suppress them.

Radio interference or not, the pamphleteer will not deny that from the beginning war has been the result of the growth of society which is never uniform and ever will be dependent upon varying conditions of race, climate, land and tradition. For protection in time of international disturbance and as a safeguard against internecine strife level heads will continue to depend upon our agencies of national defense, the military component of which is governed by the War Department—whose mission is to preserve peace!

Association Affairs

Tribute to Captain Soderholm

A SPECIAL meeting of the Chicago Post was held August 18, 1931, at the Chicago Club as a testimonial and farewell to Capt. Walter H. Soderholm, Ord. Dept., U. S. A., who has served as Secretary of the Post since 1926 and as Executive Officer of the Chicago Ordnance District, and who is leaving Chicago for a tour of service in the Philippine Islands. A large group of members of the Post, officers of the Regular Army and Navy, distinguished industrialists of the Chicago area and reserve officers was in attendance. Maj. A. K. Hamilton, Ord. Res., President of the Post, was toastmaster. In bidding farewell to Captain Soderholm welcome was also extended to Maj. R. R. Nix, who has taken up his duties as Executive Officer in the District and as an official of the local post. Maj. W. H. Damon, Northern Trust Company of Chicago, was appointed Treasurer of the Post.

The toastmaster paid deserved tribute to Captain Soderholm and to his splendid work while in Chicago. On behalf of the members of the Post and the reserve officers of the district, Major Hamilton presented the retiring official with a wrist watch in appreciation of his great service. Captain Soderholm responded with very pertinent remarks which further endeared him to the warm friends he is leaving. Letters of regret at their inability to attend the meeting were read from the Assistant Secretary of War, Hon. Frederick H. Payne, and the Chief of Ordnance of the Army, Maj. Gen. Samuel Hof.

The principal speakers at the meeting were Adm. W. S. Crosley of the Great Lakes Naval Station; Gen. Frank Parker, Commanding General of the 6th Corps Area; Mr. E. A. Russell, Chief of the Chicago Ordnance District; and Capt. L. J. Dillon, Executive Officer of the St. Louis Ordnance District. General Parker laid special emphasis on the need for educational orders for munitions and expressed his desire to send copies of the resolutions of the American Legion on this subject to each member in attendance at the meeting. Mr. Russell paid high tribute to the work of Captain Soderholm and extended greetings to his successor, Major Nix. Captain Dillon gave a brief resumé of the work being accomplished by the Army Ordnance Association for industrial preparedness in the St. Louis District. He emphasized the importance of the Soderholm plan in facilitating the compilation of industrial surveys.

ARMY ORDNANCE adds its word of congratulation and thanks to Captain Soderholm whose untiring efforts in the cause have met with well-deserved success. We join with his associates of the Chicago Post and of the Ordnance District in sincere thanks and in best wishes for a pleasant tour of foreign service.

Reserve Officers Study Cold-working Process

TO eight officers of the Ordnance Reserve Corps goes the distinction of being members of the first group to pursue a course in the theory and practice of centrifugal casting and cold-working as applied to the manufacture of cannon at the Watertown Arsenal. They were members of a class of 17 reserve officers who received active-duty training at the Arsenal from July 5 to 18, 1931. Officers registered for this special course were: Capts. George H. Knode and Theodore R. Snyder, and Lieuts. John E. Bergain, Ivan W. Lord, Stephan Terpak, Harold B. Toothe, Harry W. Tuttle, and Charles T. Schulz. All were enthusiastic over the subject matter agreeing that it was one of the most interesting and important phases of ordnance training they had encountered in any tour of active duty. One of the requirements of the course was the solution of a problem involving the organization and set-up of facilities to produce a given number of cannon of a specified type per day.

Other reserve officers on duty at the time were the following who pursued the course for inspectors of ordnance: Lieut. Col. Edmund D. Campbell, Ord. Res.; Lieuts. Frank A. Valente, Clinton M. Vernon, Thomas J. Noonan and Allen G. Shepherd, and Lieut. Col. John L. Hughes, Maj. George H. Higgins, Capt. John C. Solberg and Capt. Edmund B. Moore, were given special assignments.

Nine continuous days of rain and cloudiness failed to dampen the ardor of the group. Col. T. C. Dickson, Commanding Officer of the Arsenal, and his assistants placed at their disposal every facility for instruction. The "cannoneers" owe a debt of gratitude to Major Higgins, one of the reserve officers, for his unfailing fund of technical knowledge and excellent suggestions which were of much assistance in solving their problems. Several of the members of the group saw to it that there was no lack of after-hours diversion so that the stay at the Arsenal was not all (cold) work and no play!

Colonel McFarland Appointed to High Post

ANNOUNCEMENT was made on July 10, 1931, of the appointment of Lieut. Col. Earl McFarland, Ord. Dept., U. S. A., as Executive Officer to Col. Frederick H. Payne, the Assistant Secretary of War, to succeed Maj. Gen. Irving J. Carr, who was recently appointed Chief Signal Officer of the Army. The announcement of his appointment to this important post will be received with much gratification by Colonel McFarland's many friends in the Army Ordnance Association.

Born in Topeka, Kansas, he was appointed to the United States Military Academy in June, 1902, and upon graduation was commissioned a second lieutenant of Artillery. In 1910 he was detailed in the Ordnance Department and was stationed at the Watertown Arsenal and later at the Sandy Hook Proving Ground. In 1912 he served as Assistant Professor and Instructor in Ordnance and Science of Gunnery at the Military Academy, which position he held until 1914, thereafter serving for one year with the Coast Artillery at Fort Totten. In 1915 he was ordered to Washington, D. C., for duty in the office of the Chief of Ordnance where he served at various times as assistant to the Chief of Ordnance and in the Coast Artillery, Small Arms and Aircraft Armament Divisions and as a special assistant in charge of aircraft armament and trench warfare matériel.

In April, 1918, he sailed for France for duty in charge of the Small Arms Division and returned in August of the same year to become Executive Officer to the Chief of Ordnance where he remained until June, 1920. From that time until 1924 he was stationed at the Springfield Armory as officer in charge of the Shop Planning Division and as Inspector of Ordnance. He then returned to the United States Military Academy as Professor of Ordnance and Gunnery and Post Ordnance Officer upon which duty he remained until August, 1929, when he became a

student officer at the Command and General Staff School, Fort Leavenworth, from which he was graduated in June, 1931.

Colonel McFarland was awarded the Distinguished Service Medal with the following citation: "For exceptionally meritorious and distinguished services, first in charge of the design, development and production of all machine guns, automatic rifles and accessories thereto, for the Army of the United States, for service in organizing the industries of the country to meet the unprecedented demands for automatic arms created after the entrance of the United States into the World War, and later as special assistant to the Chief of Ordnance in charge of all matters pertaining to small arms, automatic arms and equipment."

Reserve Officers Follow Procurement Course

ELEVEN officers of the Birmingham Ordnance District attended a training course held at the district office from July 13 to 26, 1931. Instructors for the several courses were Capt. D. N. Hauseman, Executive Officer of the Birmingham District and Capt. T. Weller Smith, Alabama National Guard. Maj. Cornelius H. Menger, Ord. Res., former Executive Officer of the District, also assisted in several courses.

The following officers were enrolled as students: Maj. R. E. Parker; Captains R. M. Wood, Chas. R. Thompson and B. C. Cox; First Lieutenants S. A. Marshall, L. G. Huggins, C. W. Cheatham, R. J. Stockham and C. T. Brasfield, Jr.; and Second Lieutenants R. M. Allman and M. P. Ledbetter.

The course consisted of lectures on the basic principles of ordnance procurement. They included inspection trips to several of the larger industrial plants in the district and a number of practical classroom problems. Artillery ammunition was one of the principal subjects for study, while organization of the Army and other broader principles were discussed. Three afternoons of each week were devoted to pistol marksmanship and equitation. All student officers fired the dismounted pistol course, five qualifying as sharpshooters and the remaining officers as marksmen.

Col. John Stephen Sewell, Chief of the Birmingham Ordnance District, who was temporarily absent in Chicago during the course, forwarded a written message of congratulation to the officers, while Col. Theodore Swann, the Assistant District Chief, delivered a lecture to the class on the importance of the work in which they were engaged.

Colonel William M. Hogg

THE death on August 17, 1931, of Lieut. Col. William M. Hogg, Ord. Res., a member of the Army Ordnance Association and an official of the National Tube Company at Pittsburgh, is announced with regret. An active member of the Pittsburgh Post of the Army Ordnance Association and Chief of the Executive Division of the Pittsburgh Ordnance District, Colonel Hogg rendered outstanding service to the advancement of ordnance during the World War and in the intervening years.

He became Chief of the Facilities Service of the Pittsburgh Ordnance District during the World War and served in the grade of captain and later major, Ordnance Department. In the "History of the Pittsburgh Ordnance District" Mr. Ralph M. Dravo, the District Chief, writing of the work of the Facilities Service under Colonel Hogg, called attention to "the fact that the increased facilities of the district at no time interfered with p duction is conclusive evidence that they were handled well."

After the Armistice Colonel Hogg was appointed chairman of the Pittsburgh District Salvage Board and also served as a member of the Claims Board of that district which was organized on December 9, 1918. The jurisdiction of this board included the negotiation, settlement and payment of claims of contractors arising out of the suspension of operations and curtailment of ordnance contracts which were within the powers of the Chief of Ordnance to determine.

On July 31, 1919, Colonel Hogg was honorably discharged from the Army and shortly thereafter was appointed a civilian member of the board on a dollar-a-year basis. Later he accepted a commission as major in the Ordnance Reserve Corps and on January 18, 1924, was promoted to the grade of lieutenant colonel, which commission he held at the time of his death.

The personnel of the Pittsburgh Ordnance District and officials of the Pittsburgh Post, Army Ordnance Association, will greatly miss the coöperation and genial friendship of one who so willingly gave of his time and helpful advice to the activities of the district and to peace-time munitions problems of national defense.

Necrology

SINCE publication of the last issue of ARMY ORDNANCE notice has also been received of the death of Howard H. Payne, Pawtucket, R. I.; James H. Pickup, Newark, Del.; and Beverly L. Worden, West Orange, N. J. To the relatives and friends of these members the Army Ordnance Association extends condolences.

New Members

The following have been admitted to membership in the Association since the last issue of ARMY ORDNANCE: Charles A. Aubrey, Lakewood, Ohio; A. D. Benson, Wickliffe, Ohio; Tracy J. Calhoun, Cleveland, Ohio; Tyler W. Carlisle, Cleveland, Ohio; Carl L. Cleeland, Butler, Pa.; Thomas H. Eddy, Pittsburgh, Pa.; Carl E. Ernst, Rochester, N. Y.; Edward A. Green, Cleveland, Ohio; Ted Harwood, Westfield, N. J.; A. G. Herreshoff, Detroit, Mich.; Emil Kardos, San Francisco, Calif.; William H. Kast, Cleveland, Ohio; Matt Lehmann, Oxnard, Calif.; Chas. P. Lieblein, Cleveland, Ohio; H. J. Love, Cleveland, Ohio; Edgar J. Mills, Cincinnati, Ohio; W. T. Palmer, Middletown, Conn.; Floyd T. Ridley, Wilmington, Del.; John S. Swauger, Turtle Creek, Pa., and D. R. Weedon, Middletown, Ohio.

Association Membership

THE Constitution of the Army Ordnance Association contains the following provisions in respect of membership in the organization:

"SEC. 1. Full membership in the Association shall be open to all men who are American citizens and who are interested in promoting the cause of industrial preparedness, particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of Ordnance material.

"SEC. 2. Life membership in the Association shall be open to all men who are American citizens and who are interested in promoting the cause of industrial preparedness, particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of Ordnance material.

"Life membership shall continue during the lifetime of the life member and shall expire at death. It shall not be transferable.

"SEC. 3. Student membership in the Association shall be open to all men who are American citizens and who are students in technical schools or colleges. Student members shall not vote or hold office in the Association.

"SEC. 4. Group membership in the Association shall be open to all individuals, firms, companies and groups controlled by American citizens who are interested in promoting the cause of industrial preparedness, particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of Ordnance material."

Professional Notes

The 6-Wheeled Armored Car, T4

ALTHOUGH a few experimental armored cars were built by the Ordnance Department during the World War, armored cars are a comparatively new development with us. In 1928 a small number of experimental armored cars were put in service with the Experimental Mechanized Force. There are now in service two troops of armored cars equipped with experimental cars of four general types.

Armored cars in the past have been built on the basis of mounting the necessary armored body on a commercially available chassis, either truck or passenger-car type. This procedure has been somewhat unsatisfactory because of the compromises involved: if a truck chassis were used sufficient strength was obtained but the resulting vehicle was too heavy and underpowered; on the other hand, if a passenger car chassis were used the weight was kept down but the chassis had insufficient strength in certain respects although sufficient power was available.

To overcome these objections and to keep the gross weight of the vehicle within the limits desired by the Chief of Cavalry, there has been developed the 6-wheeled armored car, T-4. This is the first 6-wheeled armored car with the four rear wheels driven which has been built for our Army. In this case the use of a commercial chassis was not only inadvisable for the reasons given above, but because a sufficiently light 6-wheeled chassis was not obtainable, as commercial 6-wheeled chassis are built primarily for heavy duty. It was, therefore, decided to build this car incorporating a principle used in tanks, that is, no chassis is used but the hull itself forms the chassis. This is entirely practicable because the armored hull itself has greater strength than any standard chassis. The axles and springs carrying the wheels are then attached to the hull similar to the attachment of the track rollers to the hull of a tank. This has effected a considerable saving in weight and reduction in the overall height of the vehicle. This armored car (see page 99) is now undergoing tests at the Aberdeen Proving Ground and to date the results have been, on the whole, satisfactory. The car has the following general characteristics:

Total weight: without crew or ammunition, 8500 lbs.; Wheel base: (center of front axle to center of rear wheel bogie), 120 inches; Engine: Cunningham 8-cylinder V, 480 cu. in., 135 brake horsepower; Transmission: four speeds; Brakes: 6-wheel mechanical; Crew: four men; Armament: 1 caliber .50 air-cooled machine gun and 1 caliber .30 air-cooled machine gun in combination mount in turret having 360 degrees traverse, 1 anti-aircraft machine gun mounted on turret roof; Armor: against caliber .30 service bullet at all ranges; Cruising radius: 200 miles; Overall height: 84 inches.

It will be noted that two spare tires and wheels are carried, one on either side of the vehicle; in addition to being spare tires these wheels are free to revolve so that in going over rough ground they may carry part of the weight of the vehicle and prevent its being hung-up on obstructions with resultant injury to the engine, etc.

This vehicle was manufactured for the Ordnance Department by James Cunningham, Son & Co., Rochester, N. Y. This company has produced other types of fighting vehicles now in use by the Army including several experimental light tanks.

Status of Air-Cooled Machine Gun

AN interesting study has been submitted to Maj. Gen. Stephen O. Fuqua, the Chief of Infantry, by the Infantry Board on the subject of air-cooling for heavy machine guns. As a result of the study the following points have been raised:

1. In the development of the heavy machine gun in our service, we have accepted on faith the dogma that water-cooling is an essential feature of such a weapon.

2. It is desirable to seek a substitute for water cooling because of its following disadvantages: a. It complicates supply because:

(1) An anti-freeze solution must be added to the water in winter; (2) In arid regions, scarcity of water may incapacitate the gun, and (3) To keep the gun in action, it must be kept supplied with both water and ammunition.

b. It renders the gun more vulnerable because: (1) Lacking suitable precautions not always feasible in combat, the escaping steam betrays the position, and (2) A hit, not necessarily incapacitating an air-cooled gun, would cause the water jacket to leak, whereupon the gun would soon cease to function.

3. A substitute for water cooling has been sought in various cooling devices applied to light guns, all of which have been pronounced unsatisfactory for a heavy machine gun in general. a. The accuracy-life of the barrels was not as great as with water-cooling; b. They did not keep the gun cool enough to prevent frequent malfunctions during long sustained rapid fire; and c. Overheating caused early "keyholing" of projectiles thus rendering the gun unsafe for overhead fire.

4. The Infantry Board feels that the facts do not justify the conclusion that "air-cooling is unsatisfactory for a heavy machine gun," the term "machine gun" being used in the sense of a weapon of the capacity of the water-cooled Browning.

In all comparisons within the Board's knowledge, the air-cooled weapon was 10 pounds or more lighter than the water-cooled weapon; hence the only justifiable conclusion is to the effect that "a light air-cooled gun has not the sustained fire-power of a heavy water-cooled gun."

It seems obvious that an air-cooling device of greater weight of metal, and of greater radiating surface, would be more effective than those on the light guns tested to date; but, so far as is known to the Infantry Board, no heavy air-cooled gun has been considered whose weight is comparable to that of the water-cooled Browning.

5. In view of the advantages accruing by eliminating the need for water, the Infantry Board feels that it would be well worth while to undertake the development of the most efficient air-cooled machine gun that can be produced within the weight limit (37 pounds) of the present water-cooled Browning machine gun.

6. a. The Infantry Board therefore recommends that the Chief of Ordnance be requested to ascertain: (1) The theoretical maximum capacity for sustained fire of a machine gun weighing 37 pounds and equipped with the most efficient air-cooling device known; (2) How this problem of air cooling would be effected by changing to caliber .276; (3) What reduction in the weight of the water-cooled gun would be possible by changing to caliber .276; and (4) Enough exterior ballistic data for ranges under 2,000 yards (angles of elevation and fall, remaining veloc-

ity and energy, tables of ordinates and dispersions) to enable the Board to estimate the degree to which the cone of fire of a caliber .276 machine gun would meet tactical needs.

The Ordnance Department is proceeding as rapidly as possible to accumulate data on which to base the design for an air-cooled gun, and expects to prepare a preliminary design before the end of the calendar year. One of the causes of delay in actually starting such a design has been the uncertainty regarding caliber which will eventually be adopted for the semi-automatic rifle. Opinion is general that any light machine gun which may be proposed should be the same caliber as the rifle.

The Use of Mustard Gas in War

DURING recent months the Chemical Warfare Service of the Army has conducted experiments at Edgewood Arsenal, involving the spraying of mustard gas from a low-flying airplane. Certain newspapers, hearing of these experiments, published articles which it is feared will give to the public a wrong idea of the danger to be apprehended from such use of mustard gas in war.

At the same time, these articles, while indicating that the experiments had a defensive side in connection with the development of protection against mustard gas, minimized this aspect, emphasizing the offensive use of mustard gas in a sensational way to catch the public eye. To counteract to some extent possible misconceptions which might arise, the *Army and Navy Journal* obtained from Maj. Gen. Harry L. Gilchrist, Chief of the Chemical Warfare Service, the following explanation of what mustard gas is, its value and limitations as an offensive weapon, and the steps being taken by the Chemical Warfare Service to develop protection against it.

"Mustard gas, as it is commonly called, is a liquid at ordinary temperatures and pressures, freezing at 57.2 degrees Fahrenheit, and boiling at 417.2 degrees Fahrenheit. Its chemical name is dichlorethylsulphide, and its formula is $C_1CH_2CH_2SCH_2CH_2C_1$. When pure, it is practically colorless, but usually it is dark brown due to impurities. The odor is not strong, resembling that of watercress.

"For protection against mustard gas, a gas mask is not sufficient, because in addition to its irritating effect on the respiratory system, it is highly vesicant, that is, it burns the skin upon contact in either the vapor or liquid form, the blistering effect being much greater when the mustard gas is in the liquid form (although it never kills). If dispersed by high explosive, in shell or bombs, mustard gas is, of course, very finely divided, but larger droplets are obtained by sprinkling from airplanes. This method, therefore, will produce greater casualties, especially as it is much more difficult to protect against the liquid than against the vapor.

"There is no possibility that the United States will ever use gas in war unless it is first used by the enemy, but writers of all nationalities assert repeatedly that gas will undoubtedly be used in the next war. We must, then, be ready to protect against it in its worst form, that is mustard gas sprayed from airplanes. The Chemical Warfare Service has developed, in addition to the mask for use against ordinary gases, protective clothing which gives excellent protection against mustard gas in the vapor form, and considerable protection against the liquid form. Experiments have been made at Edgewood Arsenal with actual sprinkling of mustard gas in liquid form from airplanes for the purpose of determining the exact amount of protection afforded by the present protective clothing, and devising means for improving it.

"Even with the crude means of protection available in the World War, chemical agents caused only one-twelfth as many deaths in proportion to the number of casualties produced by them, as was the case with other weapons. Also, it is unanimously reported by the doctors of all countries that there are practically no bad after-effects in gas cases which recover. With the present improved protection, this record would be bettered in a future war, so that there is absolutely no excuse for the wild statements sometimes published that cities could be wiped out by dropping on them a few bombs filled with chemicals. In the first place, much more damage would result from the dropping of high explosive bombs on cities, as these would destroy buildings, and a great deal of time would be required to repair the damage. If chemical agents were dropped on cities in bombs or sprayed from airplanes, the effect would be greatly localized, only a few people in the immediate vicinity would be affected as the buildings would furnish a great deal of protection and it would be a comparatively simple matter to neutralize the chemicals on the ground. In the second place, chemical agents would not be wasted in this manner, because they could be used with much greater effect on concentrations of troops. But even in this use, there would be no great loss of life, not so much as with high explosive bombs, on account of the protection available against chemicals. A large number of men might be temporarily disabled but by far the greater number of them would recover, and recover completely.

"Thus, it is seen that while there is no reason to be afraid of what may happen in case of war, it is necessary to prepare for all eventualities, and the Chemical Warfare Service is doing its part."

Shell-Type Starter for Airplanes

EFFICIENT starting of aircraft engines may be facilitated by a new type of starter recently tested at Dayton, Ohio.

The new starter is of the "cartridge type," and is installed on the engine in the same location as the standard inertia starter. This apparatus is composed of a cylinder in which a piston is pushed forward by the expansion of gas from slow-burning powder set off electrically from a 10-gauge shell.

The shell is of paper construction with a brass collar. The shaft on which the starter jaw is attached moves forward and turns the engine crankshaft, the thrust being taken by a bearing in the starter. Rotation of the jaw is produced by the piston pushing together two shafts with right and left spiral threads one inside the other.

The total weight of 25 pounds would be sufficient for starting the engine 44 times. The starter itself weighs 19 pounds, with the breech and piping four pounds and cartridges running 22 to the pound. The starter measures 10½ inches in length.

Initial tests gave satisfactory results. There was no shock when the starter was fired or when it picked up the engine load, but there was a delay, however, of approximately one-half a second from the time the cartridge exploded until the engine started turning. This condition was due to the building up of pressure in the space between the breech and the piston.

The cartridge type starter was found more efficient at temperatures down to 15 degrees centigrade than the inertia starter, but below that temperature it was necessary to increase the fuel content of the shell.

The new cartridge type, which corrects disadvantages experienced with an explosive mixture type of starter tried some time ago, may provide improvement of interest to aeronautical engineering and prove useful for military use.

Improved Parachute Materials

INVESTIGATIONS are in progress toward the development and improvement of parachute materials by both the Army and the Navy. Picatinny Arsenal has conducted laboratory tests with batiste, fine cheese-cloth, voile, light-weight rayon, transparent organdie, summer silk, and sunsilk to determine their satisfactoriness as a substitute for silk in pyrotechnic parachutes.

Carbon and Alloy Steels
Toncan Copper Molybdenum Iron
Enduro Stainless Irons
Pipe and Tubular Products
Toncan Iron Pipe
Electric Weld Pipe
Bars and Shapes
Hot and Cold Rolled Strip, Plates
Black and Blue Annealed Sheets
Galvanized Sheets
Special Finish Sheets
Galvannealed Sheets
Electrical Sheets
Tin Plate
Nuts, Bolts, Rivets, etc.
Die-Rolled Products
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REPUBLIC STEEL CORP.
General Offices, Youngstown, O.

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PLUMBING FIXTURES

Acid-Resisting Enamel is an improved enamel developed by "Standard". It is impervious to common acids. Fruit juices or minerals in the water cannot roughen or discolor it. Write for the interesting book "'Standard' Plumbing Fixtures for the home".

Standard Sanitary Mfg. Co.
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Division of American Radiator & Standard Sanitary Corporation

After rejecting some materials because of either insufficient strength, excessive weight, or too great porosity, three parachutes of each of the materials—batiste, voile and sunsilk—were manufactured for test at Aberdeen Proving Ground to determine their satisfactoriness from the points of view of strength and rate of descent with a given weight attached. Considering that the metal container which houses the standard silk parachute and illuminant of the M-3 flare is not large enough to house the experimental parachutes and the illuminant, it is necessary, for the purpose of tests to substitute for the illuminant an inert material of greater density. Picatinny Arsenal is also investigating a lighter weight rayon than that previously tested, and a cotton material, commercially known as KK cloth. The latter materials showed promise in tests conducted by the Air Corps and Bureau of Standards, respectively.

As to the man-carrying types, parachutes of domestic cotton cloth developed by the Bureau of Standards in coöperation with the National Advisory Committee for Aeronautics have proven equal or superior to those made of parachute silk in strength and tear resistance and have performed well in trials by the Navy Department.

The cotton cloth was woven in the Bureau mill and in addition to proving its strength and tear resistance, met the requirements with respect to air permeability and weighed only a few tenths of an ounce per square yard more than silk cloth. The Navy tests have indicated clearly that the cotton parachute closely approached one made of silk in the performance as to rate of descent, opening time, strength and ability to function when stored in the pack for 60 days. The cotton cloth increased the weight of the equipment from 18 to 19 pounds, an increase well within practical limits.

A specification for cotton parachute cloth has been prepared, and cotton yarns suitable for this purpose are now being woven commercially in the United States.

As cotton parachutes have been in use for some time by commercial aviators because of their lower cost, the results obtained from this investigation will be reassuring to them, according to the Bureau scientists, while the military services which use silk exclusively are assured of a domestic source of supply.

Searchlight Tests

IMPORTANT tests of Army searchlight equipment for antiaircraft defense are being conducted at Fort Humphries, Va. These are said to be the most extensive trials to which latest types of equipment of this nature have been put. Personnel participating in the tests consists of three searchlight batteries of Coast Artillery with 18 mobile 60-inch antiaircraft searchlights and 8 sound locators. Attack, pursuit and bombardment planes of the Army Air Corps are participating.

The particular purpose of the exercises is to test the efficiency of the newest model searchlights, distant electrical control systems and sound locators. These new instruments have been in use for some time but previously have not had exhaustive tests under all conditions of field service. The latest antiaircraft searchlights are very efficient and with the recently developed electrical control are capable of great flexibility in following the fastest planes which may be encountered. During the tests the planes fly at all elevations from 1,000 to 1,600 feet. At times their motors are muffled to determine the efficiency of the sound locators in picking up the target. Various methods of camouflage for planes are being tried to discover whether they can hide themselves from the antiaircraft artillerymen. Smoke screens are being used to produce artificial clouds behind which the planes may conceal themselves from the searchlight beam as the bombers objective is reached.

The tests are being witnessed by a special board of officers consisting of representatives of the Ordnance Department, Coast Artillery Corps, Engineer Corps, Signal Corps and Air Corps.

Digest of Ordnance Patents

THE following digest of recent ordnance patents is by W. N. Roach, Chief, Patent Branch, Office of the Chief of Ordnance. Letters patent have been issued:

To John M. Browning, deceased, assignor to J. M. and M. S. Browning, No. 1,801,594 for a cartridge feeding mechanism. This invention covers a magazine for holding a belt of cartridges provided with the specific means for advancing the end of the belt into the feedway of a machine gun as the magazine is placed in position thereon. Also to the same inventor No. 1,800,595 for a magazine feed mechanism for machine guns. In this invention there is provided a magazine adapted to be placed on top of and to straddle a machine gun.

Also to the same inventor, assignor to J. E. Browning Company, No. 1,801,070 for a breech mechanism for firearms which aims to provide a link-action breech bolt which is an improvement on the usual toggle joint action.

To Jonathan Edmund Browning, assignor to J. E. Browning Company, No. 1,801,071 for an automatic firearm wherein specific improvements in a former breech mechanism are provided for the purpose of attaining greater simplicity and compactness of construction and greater reliability of operation.

Also to the same inventor, assignor to J. E. Browning Company, No. 1,801,072 which aims to provide an improved lock between the breech bolt and barrel extension as well as an improved accelerator and an improved safety device.

Also to the same inventor, assignor to J. E. Browning Company, No. 1,801,073 which is an improved means for a proper relative timing of the recoil and counter-recoil movements of the barrel extension and breech bolt. The invention also provides an improved safety device.

To Louis Stange, assignor to Rheinische Metall-Waaren-Und Maschinenfabrik, No. 1,801,179 for an automatic firearm with an improved breech bolt operating mechanism.

To Capt. Maurice E. Barker, Edgewood Arsenal, No. 1,801,258 for a compensating device which provides a muzzle attachment having inclined baffle plates designed to counteract recoil and to prevent the muzzle of the gun from rising.

To Karl Heinemann, assignor to Rheinische Metall-Waaren-Und Maschinenfabrik, No. 1,802,422, the main object of which is an improved toggle joint connection for the breech bolt.

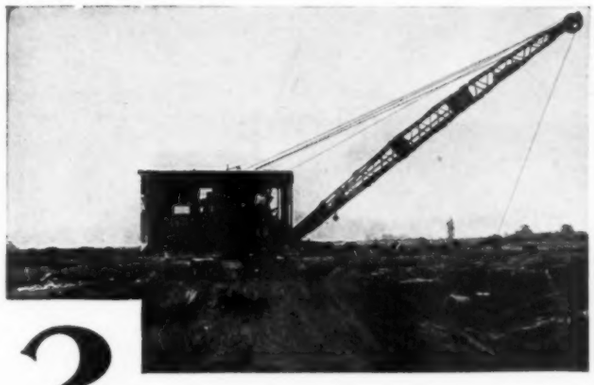
To Emanuel Holek, assignor to Czechoslovakia Zbrojovka Akciova Spolecnost V Brne, No. 1,802,816 for a gas pressure regulating device consisting of an adjustable valve regulating the flow of gas from the firearm to the gas cylinder in the arm.

To Christian Pfeiffer, assignor to Colt's Patent Fire Arms Mfg. Co., No. 1,803,349 for specific details in the construction of a reversible machine gun intended for aircraft use.

To George H. Tansley, assignor to Colt's Patent Fire Arms Mfg. Co., No. 1,803,350 for a firing mechanism for automatic firearms. This invention covers a specific detail in the fitting and firing mechanism of the reversible machine gun intended for airplane use.

To Frederick T. Moore and Christian Pfeiffer, assignors to Colt's Patent Fire Arms Mfg. Co., No. 1,803,351 for a reversible feed mechanism for machine guns.

To George H. Tansley, assignor to Colt's Patent Fire Arms Mfg. Co., No. 1,803,352 for an extractor for automatic firearms. This invention covers specific details of construction of an extractor a part of which is indicated as being reversible.



2 of every 3 dollars spent for Bucyrus-Erie machines are invested by former owners. There can be no better proof of dependable, money-making equipment than this high percentage of repeat orders.

BUCYRUS ERIE

BUCYRUS-ERIE COMPANY
GENERAL OFFICE:
South Milwaukee, Wis. U. S. A.

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Don't risk paying a fine to be told your brakes are defective. — Have them inspected regularly.

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There is a special grade of **RUSCO** for every type of brake.

THE RUSSELL MANUFACTURING CO.
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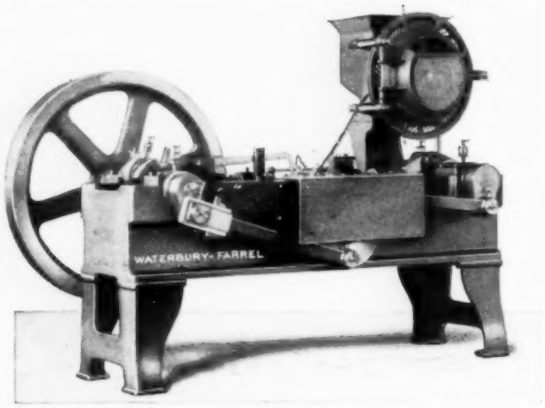
CARTRIDGE HEADER



An automatic machine for heading cartridge shells. Maximum diameter shell, 9/16 inches. Speed 80 per minute; production at 70 per cent efficiency, 3360 per hour. Weight, 6700 pounds.

In addition to our diversified line of cartridge machinery, we also build bolt and nut machinery, power presses, and wire and sheet metal mill equipment, including wire drawing machines, chain draw benches for tubes, rolling mills, etc.

The Waterbury Farrel Foundry & Machine Co.

Waterbury — Connecticut — U. S. A.

The "Osgood Victor", built by The Osgood Company of Marion, Ohio, and equipped with Vanadium Steel shafting, can be rigged as a shovel, crane, clam-shell or dragline without any changes in operating machinery

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FERRO-ALLOYS of vanadium, silicon, chromium and titanium; silico-manganese, tungsten and molybdenum, produced by the Vanadium Corporation of America, are used by steel makers in the production of high quality steels

Tough Service Calls for Tough Steels

Vanadium Forgings Meet Requirements

PACKED into a day in the life of a power shovel is more abuse than many types of machinery or equipment encounter in a year. Nobody pampers a power shovel.

In power shovel operation, shafting particularly is subject to excessive vibration, shock and strain. Abuse in severe service often causes springing or bending of carbon steel shafts, with failure an inevitable result.

In main drive shafts, reversing shafts and cross travel shafts of all Osgood machines, The Osgood Company of Marion, Ohio, employs tough, strong, enduring forgings of Vanadium Steel. Springing, bending and failures have been eliminated.

Would stronger, tougher, more durable steels improve the performance of your products and safeguard their operation and reputation? Our Metallurgists will gladly suggest analyses of Vanadium Steels that will meet your most exacting requirements. Write us today.

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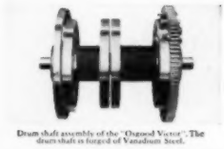
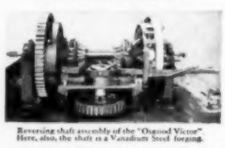
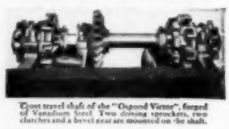
CHICAGO, Straus Bldg. — PITTSBURGH, Oliver Bldg. — DETROIT, Book Tower
Plants at Bridgeville, Pa., and Niagara Falls, N. Y.
Research and Development Laboratories at Bridgeville, Pa.



Drum shaft assembly of the "Osgood Victor". The drum shaft is forged of Vanadium Steel.



Reversing shaft assembly of the "Osgood Victor". Here, also, the shaft is a Vanadium Steel forging.



Cross travel shaft of the "Osgood Victor", forged of Vanadium Steel. Two driving sprockets, two clutches and a bevel gear are mounted on the shaft.

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Reprinted from Steel, July 6, 1931—Metal Progress, September—Iron Age, September 24, 1931

To Bethel Abiel Revelli, assignor to Metallurgica Bresciana Gia Tempini, No. 1,803,946 for an automatic firearm actuated by compressed air. In this arm the breech is utilized as a compressor cylinder in which a piston works to compress air upon discharge of the piece, the compressed air being utilized to operate the mechanism.

To John D. Pedersen No. 1,804,511 for a combination of cartridge clip and follower. This invention aims to provide a cartridge clip to hold a double row of cartridges in staggered relation and a follower having enough of its surface automatically moved by the lower most cartridges in the clip to present an upper and lower step irrespective of which side of the clip the lowermost cartridge occupies.

To Lars Eric M. C. Dahlberg No. 1,804,825 for means on firearms for measuring angles in the field. In this invention the breech bolt operating handle is provided with indicia so positioned as to measure angles when sighted from a fixed position on the stop.

To Karl Danthine, assignor to Heinrich Surber, No. 1,805,278 for a rifle attachment for firing miniature ammunition. Here a small-bore barrel is attached to the front of the ordinary rifle barrel and a firing rod inserted in the bore of the regular rifle barrel is operated to fire the cartridge seated in the cartridge chamber of the auxiliary small-bore barrel.

To Leon Thiry No. 1,805,383 for an automatic pistol. This invention aims to provide a mechanism whereby, if a cartridge is still in the cartridge chamber when a new magazine is inserted, a safety lock mechanism is automatically drawn to a safe position.

To George Ironside, assignor to Colt's Patent Fire Arms Mfg. Co., No. 1,805,547 for a machine-gun mount. In this device there is provided a cradle having pivotally mounted arms in which the gun is trunnioned which arms may be swung upwardly and rearwardly when the gun is to be used in high angle firing.

To Charles L. Ross No. 1,805,601 for a specific operating mechanism for gas-operated gun.

To Archibald R. Brinkerhoff No. 1,807,727 for a safety lock for firearms.

To Cesare Soncini, assignor to Societa Italiana Ernesto Breda Per Costruzioni Meccaniche, No. 1,809,222 for an automatic firearm having a recoiling barrel and an amplifying push lever. The invention covers specific details of construction in the operating mechanism and firearm.

To Walter J. Sutton No. 1,809,257 for a receiver sight for army rifles, being a specific form of sight to be attached to the receiver of the regulation Army rifle.

To Rudolf von Frommer No. 1,809,741 for an automatic firearm, with an improved operating handle.

To Fritz Herlach, assignor to Rheinische Metall-Waaren-Und Maschinenfabrik, No. 1,810,243 for a trigger mechanism for firearms mounted on a carriage and having a pointing handle. In this device a ring rotates about the axis of the pointing handle to release the firing mechanism.

To Chester T. Neal No. 1,811,093 for a cartridge clip. This invention covers a specific form of clip intended to hold a double row of cartridges in staggered relation and so constructed that the clip may be fed into the magazine of a gun either end first.

To Carl A. Larsson and Percy R. Higson, assignors to Vickers-Armstrongs, Ltd., No. 1,811,693 for a gas-operated machine gun and automatic small arm wherein use is made of a special form of gas port designed to prevent the collection of extraneous matter to eradicate fouling of the port.

To Carl A. Larsson and Percy Reuben Higson, assignors to Vickers-Armstrongs, Ltd., No. 1,811,694 for a drum magazine for machine guns and automatic small arms.

To Maj. James L. Hatcher, Ord. Dept., U. S. Army, No. 1,808,847 for a belt feed mechanism for machine guns. The main object of this invention is to relieve the strain imposed

on the return spring by providing a separate spring for actuating the belt feed mechanism.

To Maj. Cecil G. Young, Ord. Dept., U. S. Army, No. 1,808,877 for a propellant charge for projectiles and method of forming the same wherein use is made of a specially formed combustible coating or container.

TO George M. McCann, Office of the Chief of Ordnance, No. 1,795,568 for a novel and efficient sear for use with a tasker firing mechanism.

To James C. Karnes, Office of the Chief of Ordnance, No. 1,797,867 for an omniscope. The device provides universal vision for one in a tank or other inclosure.

Also to Mr. Karnes No. 1,801,009 for an elevation indicating device for ordnance of the howitzer type for use where varying powder charges are applied for different zones of fire.

Also to the same patentee, Nos. 1,803,939 and 1,804,992, the former invention is to provide novel means for displacing gun sight mounts corresponding to the vertical and horizontal lead to be given to the gun; the latter is for a mechanism in which indices may be registered both by sense of touch as well as visually.

To Charles B. Dygert and Coral T. Van Alstine, assignors to Remington Arms Co., Inc., No. 1,795,111 for an improved extractor and ejector for firearms.

To William L. Little No. 1,796,757 for a novel shell extracting and ejecting device.

To Alonzo F. Gaidos, assignor to Colt's Patent Fire Arms Mfg. Co., No. 1,797,951 for a firearms magazine with manual means for retracting the follower and follower spring when loading.

To Bert F. Baker, Office of the Chief of Ordnance, No. 1,800,276 for a gun-mount for a tank or armored car in which the mount may be elevated hydraulically using excess oil provided from the transmission of the vehicle.

To Capt. Elmer C. Goebert, Ord. Dept., U. S. A., and Harry C. Zimmerman, Office of the Chief of Ordnance, No. 1,801,423, for a gun carriage designed as a field carriage which may also be used for antiaircraft fire.

To Harry A. Knox, Office of the Chief of Ordnance, Nos. 1,804,470 and 1,805,771. The former is for an endless band track for vehicles, and covers a specially constructed flexible band track to which the grousers are attached in a novel manner to prevent weakening of the track and causing breaks therein and at the same time to preserve great flexibility in the track. The latter invention concerns a power plant for a track-laying vehicle and is designed to conserve space and weight, by utilizing the cooling medium for the power plant as a means for maintaining proper air circulation within the tank.

To Fritz Herlach and Hans Ludwig, assignors to Rheinische Metall-Waaren-Und Maschinenfabrik, No. 1,803,251 for a breech closure. This invention aims to provide a safety mechanism and a breech-opening device and firing mechanism for a cannon.

To Thomas A. Conlon, Office of the Chief of Ordnance, Nos. 1,803,523 and 1,804,388. The former is for a gun in which the gases of discharge are utilized to check recoil and to counterrecoil a gun and in which is provided means for holding a gun in battery when the gun is in elevation. The latter is for a gun in which the gases of discharge are used to check recoil, the mechanism being so designed that a variable recoil may be obtained.

To Hermann Schuler and Anton Gietmann, assignors to Rheinische Metall-Waaren-Und Maschinenfabrik, No. 1,803,775 for a fuze setting machine electrically controlled from the observing station.

To Werner C. L. Haubroe No. 1,801,654 for a mount consisting of an annular frame having vertically adjustible feet and a mount for machine guns to rotate on the annular frame.

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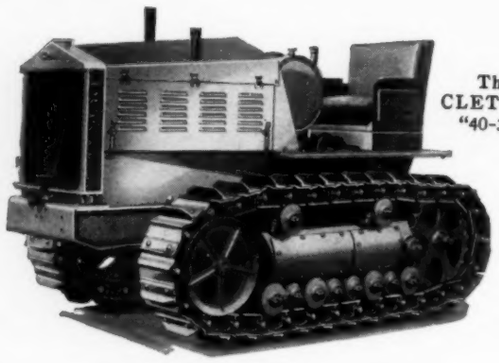

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Book Reviews

Conscientious Objectors in the Civil War. By Edward Needles Wright. Philadelphia: University of Pennsylvania Press. 1931. $3.00.

THIS is a fascinating study of American psychology during an exceptionally sensitive period of our history. It deals chiefly with the Society of Friends in the North and South because that society was the largest of the so-called noncombatant religious denominations; it was more active and therefore best known to the authorities and it was the only organized body claiming unconditional exemption from military service on the grounds of conscience.

The purposes of the author in preparing this analysis explain the nature of the text. He sought to discover the types of individuals and the denominations actually opposed to war on conscientious grounds, to determine what efforts were made on behalf of objectors and what changes took place in their political status; to learn the attitude of civil and military leaders towards them; to ascertain their numbers and finally to compare the problem of the Civil War with its counterpart in the United States during the World War.

In this latter connection the following paragraph is of especial interest: "Perhaps a better idea of the type of objector (in this country in the World War) can be gained by reading the recorded objections to military service of about five hundred men in five of the military camps. To 125 of them war was forbidden in the Scriptures in general; to 120 it was forbidden by conscience; to 115 by church and creed; to 95 by Christ specifically; to 60 by the Commandments; to 21 war was wrong in and of itself; to 16 war promoted evil; and 30 had objections of some other type." Also of particular interest is the tabulation showing the severity of court-martial sentences imposed upon conscientious objectors. Of 503 objectors tried, 166 sentences were finally approved to serve 25 years, while in some cases (18) 30-year sentences were meted out and in 2 cases 50-year terms were decreed. All in all, Mr. Wright has presented an enlightening and highly significant study.

Bismarck and Mussolini. By Charles H. Sherrill. Boston: Houghton Mifflin Company. 1931. $3.50.

THE thesis presented in this book is an attempt to draw parallels between the actions of Bismarck and Mussolini at epochal periods in the career of each; as to whether these parallels are always justified must be left to the individual reader. The book contains quite an amount of sentiment engendered by the author's repeated descriptions of his meetings with various personages, and repeated reference to personal acquaintanceship tends to impress upon the reader the personality of the author rather than that of his heroes. All this has nothing to do with the attempted parallels, and hence gives the book a rather amateurish flavor, but aids in presenting the intense admiration which the author appears to have for these two individuals.

Some of the similes presented, such as the ivy of Allington Castle, seem rather far fetched and should have no place in a book intended to be history, or a supplement thereto.

Quite some space is given to "going to Canossa," to the parallel of Bismarck's "Kulturkampf," or his struggle with the Roman Catholic Party, and Mussolini's 1929 Vatican Agreement. But from today's facts it seems the latter did not meet

with the same ultimate measure of success as the former, as witness the Pope's encyclical of June 29, 1931.

The style of the book makes reading easy, and it is recommended to all who may be interested in rounding out their information covering the lives of these two statesmen.

Tacna and Arica. An Account of the Chile-Peru Boundary Dispute and the Arbitrations by the United States. By William Jefferson Dennis. New Haven: Yale University Press. 1931. $4.00.

TO the great treasure of nitrates buried in the guano lands of the South American deserts is directly traceable the War of the Pacific which brought no solution of the disputed boundaries of Chile and Peru. It was not until 1929 that the issue was settled by direct negotiation. The causes and effects of this page from the history of South America are narrated by the author in a well-documented account. The text presents ample evidence of painstaking research and recounts the developments through each succeeding phase of this lengthy dispute.

Aside from the economic value of the treatise and its forceful presentation of the importance of nitrates, there are chapters describing the intervention of the United States following the capture of Lima, January 17, 1881; the Treaty of Ancon and at a later date the Harding-Coolidge Tacna-Arica mediations, the attempted plebiscite of 1925-26 and the final settlement in 1929. Of particular interest is the author's description of the War of 1879 when the sling shots of the descendants of the Incas were exchanged with the field artillery of the day and when wooden ships sailed beside 9-inch armored cruisers. The book is made possible by the fund established in memory of Ganson Goodyear Depew.

Thunder Over Europe. By E. Alexander Powell. New York: Ives Washburn. 1931. $3.00.

THE reviewer regrets that space is not accorded him to say all he wishes regarding the "meat" within the covers of this book. It should be read by everyone desirous of keeping abreast with European conditions. Colonel Powell's exposition of the results brought about by the pusillanimity of the Supreme Council and the weakness of the League of Nations in any crisis which has confronted it, is especially commendable, for we still have with us many who feel we should join hands with the Geneva conclave.

The author starts out to tell the truth as he sees it, and his sight is supported by incontestable evidence. He sees four major danger spots: Polish Corridor, the Balkans, the Adriatic shore, and Soviet Russia. The crimes committed by Poland, with French backing, in the Corridor and Upper Silesia cause justice to be cried for in vain, and they lay the powder train which at any moment may start the conflagration. The injustice accorded the minorities in the new states forming the crazy-quilt map of present Europe, and to which the League turns a deaf ear, will have to be rectified if this thunder is not to break into storm.

The major area of danger is considered to be Albania and the Adriatic shore, where the death of King Zog would upset the apple cart. The constitution of the Soviet Republics, their aims and accomplishments, are so presented that every American should hesitate before advocating the recognition of these enemies of established order. We have become so surfeited with misinformation regarding Russia, through propaganda and statements from returned tourists, that one gives up in despair all attempts to fathom the truth. This book places Russian conditions before the reader in such manner that he is compelled to understand.

Colonel Powell prophesies that the next few years—perhaps the next few months—are bound to form one of the most significant periods in German history. This prophecy has been fulfilled quicker than he thought, since Germany needs help, but it

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appears this can be accorded only when accompanied by political considerations laid down by France, the richest and most powerful, but also the most hysterically frightened, nation in Europe, living in extreme fear of what disarmed Germany may do to France over night.

The influence of France, the building up of the Little Entente by her, her desire to break Germany for all time, is fully explained, but one must read the book to learn the author's views of France's aims and what she has accomplished in this direction since the termination of the war.

Elementorum Jurisprudentiae Universalis Libri Duo. By Samuel Pufendorf. Edited by James Brown Scott. Vol. I: A Photographic Reproduction of the Edition of 1672 with an Introduction by Hans Wehberg, a List of Errata, and a Portrait of Pufendorf. Vol. II: A Translation of the Text, by William Abbott Oldfather, with a Translation (by Edwin H. Zeydel) of the Introduction by Hans Wehberg, and an Index. London: Oxford University Press. 1931. $10.00.

THESE volumes are recent additions to the series of classics of international law originally undertaken by the Carnegie Institution of Washington in 1906 at the suggestion of Dr. James Brown Scott, then Solicitor for the Department of State. On January 1, 1917, the undertaking was transferred to the Carnegie Endowment for International Peace. As with other publications of the series the text is reproduced photographically from the original and is accompanied by an English version prepared expressly for the series by a competent translator. Together they offer authentic source material of classical texts for scientific study.

Of this work of Pufendorf, which arose from his meditations on the works of Grotius and Hobbs, it may be said to be the standard text on international jurisprudence of the 17th and 18th centuries. Arranged in the geometric method the author begins with twenty-one definitions and follows these in the second book with two axiomata and five observations. In such manner a complete analysis of natural law and conduct in their relation to the responsibilities and rights of states is presented. Arbitrament by war, rather than peaceful conciliation, is the center of the discussion. War for just cause when vital matters are at stake, as in the works of Grotius, is fundamental to Pufendorf and yet it is his basic concept that the natural law determines international relations which today, as three centuries ago, makes his analysis of striking importance. To us it seems that the logic and force of the dissertation are essentially natural law and therefore basically sound.

The Memoirs of Garibaldi. Edited by Alexandre Dumas. Translated by R. S. Garnett. New York: D. Appleton & Co. 1931.

GARIBALDI, Italian patriot and lover of enslaved peoples! A name to awaken patriotic instincts where they have almost ceased to exist. A failure converted into a magnificent triumph. Such in short is this story of the man who was intended to be a cleric but who rebelled and became the liberator of a great people. The book is written in the usual Dumas style, or with many more words than are necessary to tell the story.

After fleeing to South America, following an abortive revolutionary movement in Italy, he was condemned to death; this worried Garibaldi but little, and we soon find him fighting the battles of Rio Grande do Sul against Brazil. This portion of the memoirs is purported to be taken from his personal papers, but no mention is made of the severe tortures to which he was subjected when captured by the Brazilians, and which dislocated his limbs. He is next found fighting the cause of Uruguay, and he returned to Italy upon receiving word of an intended revolution there.

His South American wife, Anita, the mother of his three

children, Anita, Ricciotti and Menotti, died at Caprera, but the memoirs make no mention of his marriage to the Countess Raimondi, whom he abandoned immediately after the wedding. After the liberation of Rome he had this marriage annulled and married the mother of his children Clelia and Manlio.

The memoirs break off abruptly upon the victorious entry of Victor Emmanuel into Naples and Garibaldi's sudden return to his island home of Caprera; thus his further services in the liberation of Italy, and those rendered the French in 1870, are not mentioned. In 1874 he was elected deputy for Rome, and a few years later he accepted the first recompense for his services, a grant of £40,000 and an annual pension of £2,000. Garibaldi died at Caprera on June 2, 1882, sincerely mourned by his friends in South America and the entire Italian nation.

As a memoir the book is incomplete, and due to many repetitions it is at times tiresome, but for those interested in the life of this remarkable Italian patriot its pages contain many incidents not heretofore published.

Second Annual Directory of American Aircraft Engines. New York. International Nickel Company, Inc. 1931.

THE extent to which alloy steels in general, and nickel alloy steel in particular, are contributing to the progress of aeronautics is evident from the Directory, according to Charles McKnight of the International Nickel Company. "The same materials," he said, "are contributing largely to the progress of other steel-using industries, which constitute the outlet for steel mill production. The important and growing field of aeronautics offers a typical illustration of the modern industrial requirements which are bringing about a definite preference for nickel alloy steels in vital machinery parts."

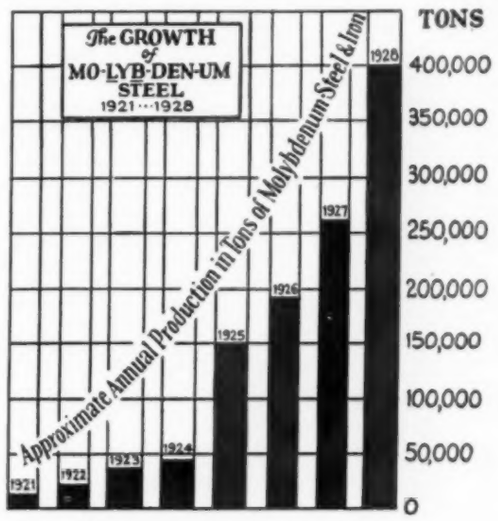
Eleven more engines are included in the 1931 Directory than in that of 1930. Moreover, whereas the 1930 issue contained no two-cylinder engines, the new issue describes four. Of those engines whose prices are given, the most expensive is the Packard Model 3A-2500, which is quoted at $15,625; while the least expensive is the Heath B-4, which is quoted at $300.

A preface to the directory points out that the important developments in materials of construction which have helped to make the airplane of 1931 a safe and dependable machine, are all too often disregarded. "The aviation engine is an offspring of the automotive industry, and the history of all automotive progress is in large measure the history of the development of alloy steels. Both the modern automobile and the modern airplane, and, more particularly, the modern airplane engine, are the products not only of the drafting room and the testing block, but also of the metallurgical laboratory."

A Soldier's Diary. By Capt. Will Judy. Chicago: Judy Publishing Co. 1930. $2.00.

THIS book is the day-by-day observations of a portion of the World War period from the viewpoint of an Army field clerk. It might have been made more interesting and it could be less so. However, one can easily accept it as the daily impression of one of the millions of our soldiers who performed his duty as he saw it and played his part in the great effort to the best of his ability.

As a cross-section of a soldier's life it is acceptable and indicates how little those who bear the brunt of campaign and battle know of the attending conditions other than in their own immediate surroundings. It is in no sense a history of the 33rd Division, the author's organization, but is intimately connected therewith. Happily, it does not dwell on the morbid and gruesome aspects of the war as so many war books do and the diary as a whole gains correspondingly. Nor is it an authentic answer to many of the questions propounded by the publishers on the cover. It is human and accordingly has a sustained interest for the reader. That, in itself, makes the book good reading.



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